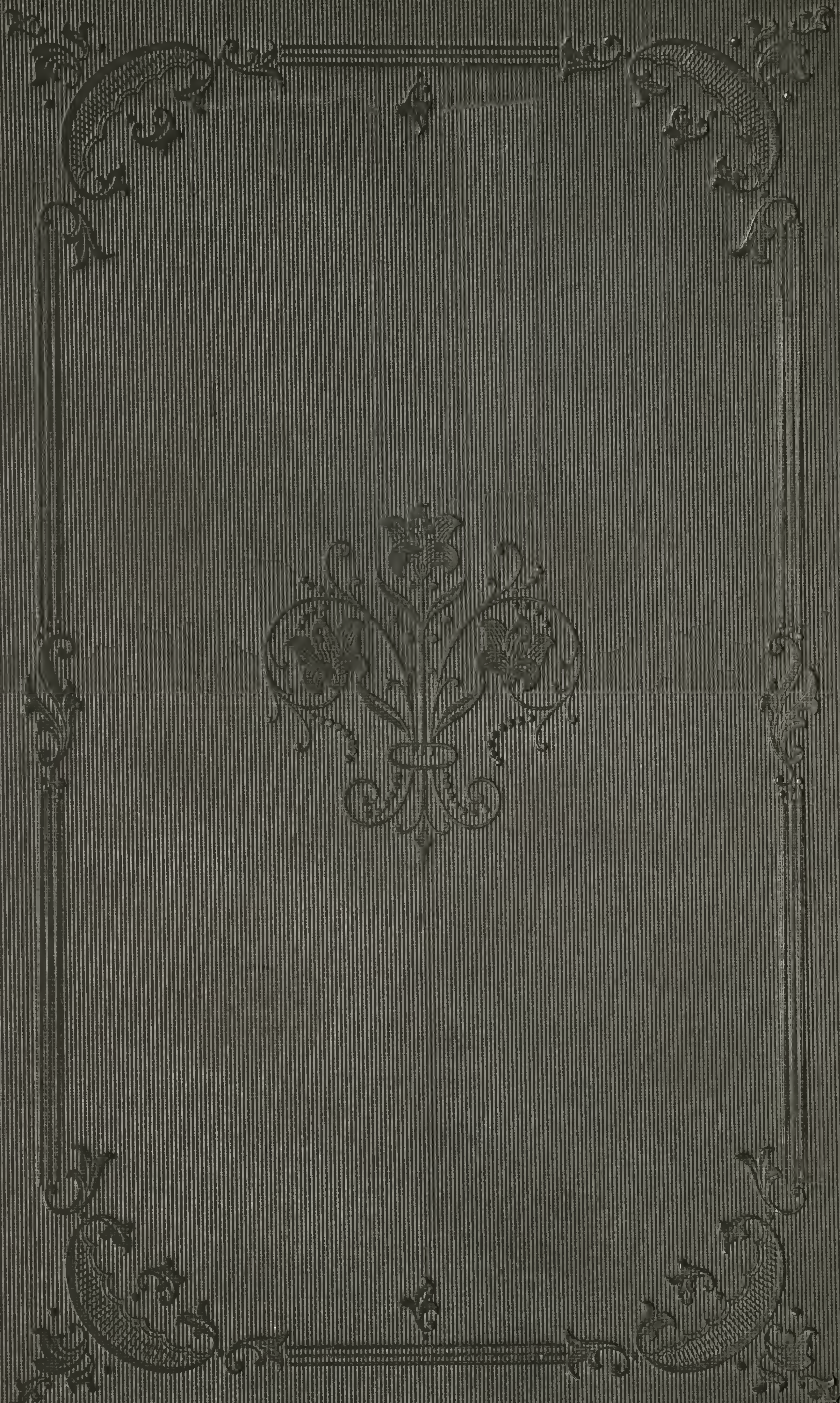

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MARK TWAIN
WORKS
HISTORY OF UNITED STATES

THE PHYSICAL LIFE.

"There is a great difference between one who is learned and one who is not, and between one who has been trained in gymnastic exercises and one who has not been. Now the rulers (of the Ideal State), male and female, * * * should see that all boys and girls alike may be sound, hand and foot, and may not spoil the gift of nature by bad habits, in-so-far as this can be avoided."

—*Plato.*

"Your body is a machine subject to well-known physical and chemical laws; and your mind depends for its operations—for its very being—on the operations of this body. * * * Your only choice is as to whether you will make your body a well-regulated, carefully tended machine, or whether you will allow it to fall into a state of slovenly despair; whether you will be the director of your habits, or their feeble slave. Stated thus there can be no question as to what should be your answer; surely there is no question as to which line of action will tend to make for greater happiness."

—*Henry Smith Williams, M. D., in "The Science of Happiness."*

"The child is healthy when he can express and occupy himself in all the demands of his spirit and body, in all his demands as a human being in a manner corresponding to his being and nature. Therefore, first of all, the child is to be healthy as far as it is possible."

—*Froebel.*

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VOL
VIII

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INTRODUCTION.

WE live in a very wonderful world. Few of us give but little thought to the fact that we are riding on a great globe or ball, and sailing through space like passengers on a great air-ship. Many more of us often think of the wonderful things that are riding with us on this world—railroads, telegraphs, wireless telegraphy, telephones, air-ships, submarines, battleships, tunnels through mountains, tunnels under rivers, automobiles, and so many other marvels that it would be tiresome to read the list. All of these wonders that are upon the earth have been made by man, and he has been able to construct them because he had life. Nothing that possesses life, except man, ever could or ever will be able to produce them. The study of man, therefore, must be even more fascinating than is that of the things which he has made.

It is the story of life which is to be found in the pages of this book. Now all forms of life, whether in plants or animals, are in some way related to one another, and are members of an enormous family; therefore we ought to know something about these numerous relatives of ours. Many substances which are found upon the earth do not have life, but they contribute something to beings that do have it, and so it will be interesting to know what some of these things are, and to find out the way in which they become a part of life.

Everybody nowadays knows what a steel-frame building is, and it seems appropriate to compare the different stories of the building with the different parts of the human structure. Furthermore, as the building, in addition to its framework, has coverings of wood and stone and paint, and linings of plaster and paper, so the human structure, in addition to its framework of bones, has coverings of muscle, and skin and hair, and linings composed of the membranes and other tissues in its interior. And just as the building has pipes and wires and tubes in its walls, so the human building has their counterpart in vessels and nerves. And as the building has machines of different kinds, so the human building contains various organs which correspond to the machines.

This is the form in which the attempt has been made to describe the way in which the human body is put together. But it is also well to know what these various organs or machines are for, and how they are run or kept going, and that has been told in the chapters which relate to functions, or physiology, or the purposes of the various parts of the body. It is also intensely interesting to listen to the story of the air which surrounds us all, which we are breathing every minute, and of the water of which most of the body is composed, and which gets in there in the form of food and drink. What kind of food should be eaten? What kind of clothes should be worn? Then there is sleep, which takes a third of our precious hours, but yet without which the remaining hours could not be lived. And the gentle but powerful influences—how blessed and fine they are—that promote growth of body and mind, through work and play in the school and the home!

Then, as everybody and every living thing in this world has enemies, from the time when life begins until it ends, it is of great importance to know what these enemies are, how they come to us, and how we can best get rid of them. The world, its plants, animals, and human beings, are made up of particles so small that one can not see them with the naked eye. Surely we ought to know something about cells, and about bacteria, the wonderful but very small forms of vegetable life which are doing much work, good and bad, for us and against us.

Then, finally, we come to the sicknesses and diseases that are liable to attack any of us, as they are only one form of the enemies we have and must try to overcome. Also, the injuries and accidents from which so many people suffer, sometimes because they can't help it, and sometimes because they are careless and ignorant. If we know about things which are bad and hurtful, it is a very important step in keeping them away, that is, in preventing them. But if they come, we ought to know something about the way of getting rid of them, and therefore a very important part of the education of every human being should be along these lines. If every person were thus informed, there would be little need of doctors.

It is said of the Chinese, whether truthfully or not I cannot say, that they pay their doctors for keeping them well, but do not pay them for recovery from sickness, as if the doctors were somehow responsible for their ills. But the helpful suggestion which we can draw from this is that, if we know how to take care of ourselves, we will not often need a doctor, certainly not as often as we do now.

It has been the constant effort in preparing this book to use simple language, and when the terms used in medical writings have been employed the corresponding words of common language have also been used, if any such words are known. There is no danger of meeting a great number of confusing terms. Fortunately, people in general know more about medical terms at the present day than they ever did before, thanks, principally, to the educating influence of the newspapers. Appendicitis, pneumonia, diphtheria, paralysis, hemorrhage, apoplexy, and hundreds of other medical terms are as familiar to the public as they are to the doctors who are constantly using them; in fact, they are more familiar than the old-fashioned terms by which some of these conditions used to be known.

I desire to thank those who have so kindly assisted me in preparing this volume. I am sure it is a great deal more interesting and useful than it could have been without their kindly help.

ANDREW F. CURRIER, M.D.

PART I.

LIFE AND GROWTH.

CHAPTER I.

The Most Valuable Possession on Earth and What We Know About it.

THERE is one thing and only one which distinguishes every plant and every animal. It matters not where or how long ago it lived, how small or how large it was, or how long it stayed here, every single one possesses it.

We see it in the simplest plant, so small that it can be seen only with a powerful magnifying glass, and we see it in the mightiest animal that flies through the air, or swims in the sea, or roams over the earth. That one thing, boys and girls, is the most interesting thing we know—so interesting that no matter how old you may live to be you will always read about it and talk about it. The greatest thing in the world is LIFE, and it is this great thing which you are now going to read about, and I am sure it will interest every one of you.

SOMETHING THAT IS EVERYWHERE AND YET IS A MYSTERY TO THE WISEST MEN.

All the plants that were buried in the rocks hundreds of thousands of years ago, all the animals whose bones have been resting for countless ages in the sand

and shells and mud and chalk in the different parts of the earth, and are dug up every now and then by those who are trying to find out the story of the world in the past, had life just as surely as you and I and the plants and animals we see around us. When did all this wonderful procession begin? Who or what made it? How was it started? What is it? These are questions which men and women have been asking ever since they began to take interest in anything besides the food they eat, the clothes they wear, and the shelter which protects them from heat and cold, storm and wind.

But with all their questioning the wise men have never yet been able to tell us satisfactorily what life is, or where it comes from. This is the great mystery which they are ever following and have never been able to catch and hold. But if we have never been able to say exactly what Life is, we certainly do know some things about it, and boys and girls should, and can, understand what these are.

ALL LIFE HAS A BEGINNING, WHICH WE CALL BIRTH.

The beginning of life, or existence, may take place in different ways; it may be by the breaking off of one part from the parent part, the new part then becoming a new living thing from that from which it separated; it may be by the swelling and unfolding in response to the influence of heat and light and air and moisture, which we see in the birth from seeds; or it may be the result of the union of elements which takes place in the egg.

In all these instances what we call life is the result, and although it is mysteriously hidden away in the seed, the bulb or the egg, when planted in the soil or otherwise nourished, birth takes place and the world is enriched by the addition of another life or series of lives.

But in the next chapter we come to something with which we are better acquainted and which we know more about, and which means a very great deal to every boy and girl who cares anything at all about laying a good foundation for a successful life.

ALL LIFE IS SMALL AND WEAK IN ITS BEGINNING.

Another important fact in connection with life is that its beginnings are so small and insignificant as to attract no attention at all. There are no brass bands and no shouting though the event may be one which is to change the course of history. You cannot see, you cannot tell the moment when a seed first changes from a dry and apparently dead substance to a thing of life ''which is to spring up and bear fruit.'' No notice was taken of the moment when life began in Washington, or Cæsar, or Luther, or Napoleon, or any of the other great men, who have done great deeds and left undying names.

Did I say you cannot see the beginning of life, that is not quite true for in the very, very small forms of life which are composed of only a single cell, you can see, if your eyes are sharp enough, and you watch closely enough when a part of the cell breaks away and becomes a new cell, a new life, but such forms of life never become anything more than a single cell, never do anything which makes any great difference in the development of the world. Most schoolboys are familiar with the poem called, *The Launching of the Ship,* and they will readily recall the stirring lines:

> "See, she starts, she moves, she seems to feel
> The thrill of *life* along her keel."

Yes, it is a thrill, an impressive feeling, a great event, this beginning of life, which is apparently so small and insignificant.

ALL LIFE IS WONDERFUL AND INTERESTING.

When we realize the possibilities that are wrapped up in the little particle of matter which has. in some mysterious way, had life added to it, we can readily be pardoned if we say, how wonderful it all is! Remember that when life begins in a human being it is in a cell 1-125 of an inch in diameter. Not until it is several days old is it large enough to enable us to study the changes which life is bringing to it, but it grows and grows, part is added to part, until at length after weeks and months and years it becomes the complete and perfect form which was originally designed.

If the sculptor's work is interesting as he models the clay, builds up the figure and at length gives us the complete image, which we admire for its lines and curves and proportions, how much more so the living image which can not only *be* but *do*. How wonderful it is too, that each kind of plant and animal is repeated year after year and generation after generation on nearly the same plan as those which went before it, not absolutely the same, for in the long ages since life first came to this earth changes have undoubtedly taken place both outside and inside in the structure of animals and plants, but these changes have taken place so slowly and so gradually that no one has yet been wise enough, so far as I know, to point out where one form has developed into another.

ALL LIFE NEEDS CARE AND TRAINING AT THE BEGINNING TO GET THE BEST RESULTS.

This is a rule which all who have had anything to do with the nurture of plants and animals know must be followed. Does a careless gardener raise fine roses or chrysanthemums? No, he is constantly caring for them when they are young, giving them plenty of water, plenty of sunshine, good soil, trimming off unnecessary leaves and branches and at length he is rewarded by the perfect flower. Does the stock breeder neglect his calves and colts, refuse them food and exercise and keep them tied up in a dark stable? Not if he is sensible and intelligent, for otherwise he would never get beautiful and productive cattle and swift horses. And in the far more important work of the teacher what pains he takes, if he is a good teacher; how patiently he struggles with the faults and the mistakes and the dullness of his pupils because he knows that in the end all his efforts will be rewarded. Does not this teach you the lesson that all your difficulties and trials are worth something as lessons, and that you should not seek tasks that are easy and that will give you no trouble? We get strong muscles as we exercise them, not by sitting still and watching others work. We get strong and active minds, and become useful, by looking difficulties squarely in the face and overcoming them.

CHAPTER II.

The Wonderful World of Growth.

HOW ROCKS AND OTHER MINERALS GROW AND HOW THEIR GROWTH DIFFERS FROM THAT OF LIVING THINGS.

ALL growth is not the same kind of growth, as we shall see, and there is a great difference between the growth of a dead thing and that of a living thing. The difference is in what *causes* the thing to grow. Minerals grow (or increase in size); but the cause of their growth is very different from that which produces growth in a plant, a tree, or a boy.

Some of the immense rocks we see were not always so large. They have been a long time in the making, and the making has been a kind of growth. Some of the rocks have been made by the action of heat. Fires within the earth (how they were started we may not know) have melted the substances which were around them, and finally the heat has become so great that the crust of the earth over the fire breaks, like the crust of a pie in a hot oven, and the melted material pours out in a stream over the surrounding earth, as the melted and liquified iron pours out in a stream from a furnace when the furnace is tapped.

When this melted material cools and becomes hard it is changed into a substance which we call rock. This rock may be miles in length, and hundreds of feet in depth or height, and it may have been many, many years before the work was entirely finished, but we may say that it was growing all the time.

But a simpler way of understanding the growth of minerals will consist in taking a small bar or rod of magnetized iron and dropping it in the midst of a small pile of iron filings or particles. Instantly these particles will move toward the rod and stick fast to it, and instead of a small rod we will now have a good sized piece.

Another simple way of observing how minerals may grow will be to take a glass of water in which a lump of salt (which is a mineral) has been dissolved. Hold it up to the light and it looks perfectly clear. Now put it over the fire and let it boil until the water has all disappeared in steam. Then look in the bottom of the glass and you will see a number of white particles. These particles are nothing more nor less than the lump of salt which was dissolved in the water. Each of these particles of salt is called a chrystal, and if you look at several of them through a microscope you will observe beautiful geometrical figures, all made exactly alike, each chrystal having exactly the shape which belongs to the mineral—salt.

Again take several mineral substances which are known to have an attraction or fondness for each other, chemically. Dissolve them in a glass of water and then pass a current of electricity through the water. Immediately each mineral will move toward the one which attracts it, and new substances will thus be formed. When the water is removed these substances may be separated from each other and their chrystals examined as the chrystals of salt were examined.

These chemical changes are going on all the time in the earth and explain the growth of many of the minerals. Minerals therefore may be said to grow in various ways, but they have no *life* such as distinguishes animals and plants, and their growth therefore is very different, both in the way it takes place and in its form and character, from the growth of living things.

WHAT ONLY LIVING THINGS DO, AND WHY AND HOW THEY DO IT. SOME THINGS BOYS AND GIRLS SHOULD KNOW ABOUT THEMSELVES.

If I ask my boy reader why he expects some day to be a man he will say at once: ''Because I expect to *grow.*'' Day by day and year by year he will get larger. Every part of his body will expand and develop until he is as large or larger than his father. The boy does what only *living* things do; he grows *because* he has *life.* It is the nature of living things to grow. At the outset, therefore, we can make these grand distinctions: minerals grow, plants grow and live, while animals (and plants in rare instances) grow and live and feel.

Now, my young readers, growth is a very interesting thing, but it is also a very important thing, especially for young people, and we must think about it and try to understand it.

We see boys and girls in school who have healthy growth and how fine they look—how full of fun and spirit! We also see boys and girls who have a stunted and sickly growth; they look so weak and miserable we pity them. I am sure every boy and girl wishes to be strong and well and healthy, and not weak and sickly, for health is the best and greatest possession we can have.

This book has been prepared to tell young people about themselves, that they may grow up with fine, healthy bodies, full of life and ambition. Therefore, let us consider something you are all doing—growing, and why and how you do it.

SOME THINGS WHICH ARE ESSENTIAL TO GROWTH.

What is it that makes an acorn grow which was dropped on the ground with thousands of others which do not grow but, on the contrary, die and fall to pieces? The acorn that grows has a little more moisture, a little more heat, a little more sunlight than the others, and lies perhaps on soil that is softer or more porous, or in other ways better adapted to nourish a living thing than the others have, and so by and by it begins to swell, and its hard covering, or shell, begins to break, tiny rootlets reach out for the earth below, and a leaf or two spring up toward the sky, and life and growth can then be seen side by side.

The same is true of animals.

Take a litter of five kittens, one or two of them die, and unless they were removed they would quickly decompose and not only fall to pieces, but produce harm to those that remain. The remaining kittens get plenty of food, have a warm bed, get plenty of sleep, and soon their eyes open, they move about, and in a week or two we notice that they are getting larger. Perhaps one of them is stronger than the others, and gets more milk from the mother, and exercises more, and in a few weeks is quite a little bigger than the others. The condition which was at the bottom of growth in these young animals was Life, those which died did not grow, those which lived grew and one of them grew more than the others.

CONDITIONS MAY BE FAVORABLE OR UNFAVORABLE TO GROWTH.

We see, therefore, that there are *conditions* which are favorable to growth and others which are unfavorable. Let us look a little more closely into these conditions. An animal or plant must have room enough to enlarge, to spread out, to get bigger. You know how the gardener does with plants; if he wants to get very fine thrifty ones, he thins them out, he does not plant them too closely together, he gives them the room which will enable them to get bigger. So also the breeder of cattle doesn't fasten his young calves to posts where they cannot move about, but he allows them to move up and down in a pen, or a yard, or even turns them loose in a field so that they may have an abundance of space to carry out all nature's requirements and have a healthy growth.

Then again with animals *motion* is essential to growth and herein they differ from plants. The muscles were placed on the bodies of animals to enable them to move them about from place to place; by using them they get stronger and larger, if they are not used they wither and shrink away, and this is true of the muscles of the wings of an insect which move several thousand times in a minute as well as of those of a mighty elephant which move very slowly.

We must not forget, however, that there are animals which never move about, especially certain low forms of sea animals like polyps, oysters, and corals. They get exercise, however, and move the muscles which they may have even though they may never leave the place in which they pass their lives.

The plants have no power of active motion, they stand where they started their lives and would remain there until their lives were ended unless removed by some force outside themselves. Force may be applied to them and cause motion, as when the wind blows a flower or a stalk back and forth, and even seems to strengthen it by such exercise if the exercise is not too violent. Even plants, therefore, may be said to be benefited and strengthened by exercise and motion.

I suppose you think that nothing can live and grow without *air,* whether plants or animals. Until very recently that was believed to be true, but it is now known that certain varieties of very humble plants, very minute, belonging to the great family of bacteria will live and grow even in places where there is no air or only a very little. If you care to know the name of these plants, they are called *anærobic bacteria,* which means bacteria which live without air.

In order to have healthy growth there must also be *sunlight,* not the artificial light which brightens our houses at night, but light from the sun, the great source of light and heat. We have seen animals and plants growing in a cave and they did not have the color which those growing in the light have; the fish in the water of the cave were small and slow in their movements and the crickets had but a feeble chirp, the darkness had paralyzed them. The plants, too, lacked the beautiful green color which comes with sunlight.

Animals and plants must also have *heat* in order to grow not only outside but inside. You know that if you put seeds into frozen ground they will not grow, and so if you are wise you will wait until the ground is warm with the spring sun, the heat from which will very soon produce the desired effect. Some animals require more heat than others, a polar bear is not comfortable on a July day in the Zoo, neither would a cow enjoy a home in the Arctic regions. Neither would grow favorably in the home of the other. The bear has more heat within him, or it might be more correct to say he has more protection from cold than the cow and he can plunge into ice-cold water and enjoy it, while the cow would be injured if not killed by it.

Growth also depends very much upon the *food supply*. Scientific men have found out that the crops of the earth—corn, wheat, oats, etc.—are much larger and better when they have the right kind of food in the soil, and so having found what the plant requires, they tell the gardener or the farmer to put it on the land, and if he does so he is rewarded with strong, thrifty, fruitful plants. Again, if a farmer wishes his animals to become large and strong and healthy he does not put them in pasture where the grass is scanty and poor but where the food is abundant and nutritious, and if they do not get enough in the pasture he gives them more when they come home at night.

So you see that many things are absolutely essential in order that plants and animals may have a strong, vigorous, healthy growth, and all these things together make up what are known as the surroundings or the environment. If the surroundings are not first class, you may depend upon it the results will be seen in very poor and unsatisfactory growth.

VARIOUS KINDS OF GROWTH.

There are yet other things in regard to growth which it is quite important for you to know. If you see a tree in the street or in the forest tall and shapely, with abundance of branches and leaves, you say at once—how well that tree has grown, how it seems to have done just as nature intended! In other words, you say the life and growth of that tree have been normal and natural. But if you see another tree, perhaps by the side of the first one which is short and ugly, with holes in the trunk which have been bored by insects, and sickly leaves and boughs, you also say—here is a tree in which the growth has not been natural, the conditions for its growth have not been favorable, it is more or less of a failure!

It is easy to conclude, therefore, that there may be a *natural* and there may be an *unnatural* growth, and this applies not only to trees but to everything that has life. Again, looking at the tree we see that it has more boughs, more leaves, more bark than it had last year, and if we cut it down and saw off the end so as to give us a smooth surface we will perhaps discover a number of rings, one within the other, and this will mean that each year one of these rings of wood has been added, thus making the tree larger. Now does this not show that there has been growth on the outside and also on the inside, and if you look deeply into the living things that are in the world you will find this process repeated in most of them.

Once more looking at the tree, I remember to have noticed once in the forest, near my home, a small evergreen tree, a mere baby two or three years old, but very symmetrical and beautiful. I said we won't pull it up because it is a balsam. In a very few years it had grown several feet taller, and the last time I saw it, it was a matter of astonishment that it had developed so rapidly. But there were other trees around it much more fully developed, and during the same period it was scarcely possible to see that they had grown at all.

So we must conclude that there is a *rapid* growth and there is a *slow* growth, and some things, both plants and animals, grow much more rapidly at some periods than at others. It often happens that those things which grow slowly and during quite a long period of time have very long lives, while those which develop very quickly have very short lives. Can there be too much growth, more than is good for the life of the plant or animal? Yes, that is quite possible too. A tree sometimes has so many branches that we must cut some of them off in order that the remaining ones may get stronger and larger; an animal, a horse we will say, sometimes gets so large and fat that he cannot do the work which is required of him. We call this unnatural growth—*overgrowth*—and very often it takes the form of disease. Perhaps you may have seen it on trees in the form of great lumps or warts, and very often it comes on animals in the form of tumors which may finally become so large or be of so injurious a character as to destroy life.

GROWTH IN HUMAN BEINGS COMPARED WITH LIFE AND GROWTH IN PLANTS AND ANIMALS.

Now all these facts which have been narrated about life and growth in plants and animals are just as true when we get at the top of the scale of life and see what takes place in human beings. The baby comes into the world, a poor, little, delicate, helpless creature, but almost as soon as it comes, if it has favorable surroundings, it begins to grow, outside and inside, slowly or rapidly. It soon outgrows its baby clothes and gives up its nursing bottle, its rattles, etc. It creeps, it walks, it runs, it leaves the nursery as the fledged bird leaves the nest. The baby becomes a child, the child becomes a youth, and changes take place of which we shall speak particularly in the succeeding chapters.

The human life is also different from life in animals and plants in many ways. In many of the plants the whole story is limited to a single season. Some of the trees, to be sure, live many years, but their story is the same as season follows season. They never move from their starting place unless they are moved by force of some kind which is applied to them. The animals, of course, show greater resemblance to human beings, many of them being built on the same general plan as human beings, and reproducing themselves in their offspring in much the same way.

But man differs from animals in that he alone stands upright, and by means of his brain and his hands is able to do thousands of things which animals cannot do; in other words, human beings live, grow, feel, and think. Man has supreme control over animals and plants, he uses them, he makes them serve him. Even the powerful wild animals of the forest and the desert are subdued and often are made to do what the will of man directs them to do. Man can adapt himself better than animals to life in any kind of a climate, for by means of his brain and his hands he can overcome the difficulties which come from a climate which is too hot or too cold, too wet or too dry.

An animal cannot overcome sickness and he dies when the strength of nature is insufficient to overcome his disease, but man has learned how to cure many diseases which, left to themselves, would destroy life. An animal has very little self-control; sometimes a highly trained and highly bred horse or dog can control himself more or less, but not to the extent that a highly trained man can. A man, by constant effort, can even change his nature from bad to good, from lazy to industrious, from bad temper to calm and reasonable temper. Man has articulate speech which the animals never have, and man has within him capabilities and powers which distinguish his life from that of animals and plants, as we shall see in the next chapter.

CHAPTER III.

What the Possession of Life by Boys and Girls Means to Themselves and the World.

THE GREAT THINGS HUMAN LIFE HAS DONE.

IF it had been left to animals to work out the numerous problems of the world and of life, you can easily see how little would have been accomplished. We have only to go back to the rocks which contain the records of animal life before human beings came into the world to find that all they did was to eat and grow and reproduce their kind and die. The world was as much of a wilderness when they went as when they came. But since human beings came everything has changed.

Let us see some of the things man has done. He found the earth a wilderness, a forest, a desert. He had what animals did not have—industry—and so he cut down the forests, and irrigated the desert, and planted corn and wheat and oats in the wilderness, and developed by far the most important part of industrial life, which we call agriculture. But by and by groups of people found it to their advantage to live near together instead of long distances apart, and then came the village, the town, the city.

Then, too, men began to sail upon the seas and the oceans. They were very timid at first and didn't dare to sail beyond the sight of land, but gradually they improved their ships, the compass was invented, the sun, moon, and stars became their guides and at length, behold! they sailed all around this globe on which we live, they carried to and traded with all nations and peoples, they built factories, shops, and mills without number, and made, with the aid of brain and hands, the most wonderful articles, some of which seem almost to have borrowed a portion of the brain which designed them.

The more men *did* the more they *thought,* the brain growing by work like every other part of the body, and finally it seemed a good thing to put thought into forms of writing for permanent record, and so literature and history were born, thought being first recorded on pieces of hard clay, then on a kind of paper made of the inner portion of certain kinds of plants (papyrus), then on the skins of animals (parchment), and finally on the paper such as we use nowadays and by means of types and printing presses which produce in an hour what required months when the writing and printing were all done by hand.

Not only did human life and human brain express themselves in things which were useful, but there also grew up a sense of that which was beautiful, and art was born, and men carved pictures upon the rocks, made images to embody their ideas, learned the use of paints and how to place them in beautiful forms and combinations upon wood and stone and canvas. They built beautiful houses and temples, and added to the beauty which they saw around them in nature, which they often endeavored to copy and imitate. And so you see in what a multitude of ways human life has been expressing itself these few thousand years it has been here.

Like the stone which you throw into the water which makes ever widening circles until they are lost to your sight, so human life, through the brain and the hands, has done all these wonderful things, searching in every nook and corner of the globe for the wealth that lies buried in them, traveling over the earth, the air, and the sea, and making the mighty forces of nature obedient to its will.

Everybody likes to see children happy and having a good time. We do not wish boys and girls to be little old men and women. Neither do we wish them to grow up to be foolish and ignorant men and women. It is good to laugh and play, but it is also good to *think*, for it is the people who think that amount to much in the world. And if boys and girls, and parents, also, would try to understand what Life is and what Life means, I am sure they would be more thoughtful and careful.

The world would not be much of a place to live in if there were no beautiful flowers, singing birds, splendid trees, delicious fruits, game and fish and animals of all kinds, and various kinds of grain to delight and sustain life. Once a year in the United States, Canada, England, and other countries, the people have a "Thanksgiving Day" or "Harvest Day" when they rejoice and return thanks to the good God who has given these productive things of life for the benefit of man. We see that the Creator has given life to all these things that they might reproduce themselves, and thus bring blessing to the world.

Now every boy and girl has a life that is the most important and valuable thing in the world because it can reproduce itself in other lives, and by its wonderful activity and energy bring marvellous things to pass—so much so that the boys and girls of the present day are living in a world that within the lifetime of their parents has been changed as if by magic. Life is therefore not something to be trifled with, but to be kept clean and pure and healthy, and when we see what a single life can accomplish it ought to make all young people anxious to lay a "good foundation" for future success while they have the opportunity.

THE VALUE OF HUMAN LIFE IS SEEN IN THE ACHIEVEMENTS OF GREAT MEN.

Perhaps we can best understand what the successful result of life means by considering some of the achievements of a few of those whose names stand out prominently as men who have accomplished great things for the benefit of their fellow beings.

First let me speak of one whose name is familiar to everybody, who chose for his field of work the marvelous force which we call electricity, and who is still with us. His name is Thomas A. Edison. He was born in Ohio in 1847, was a poor boy, and had no opportunity for education at school. While yet a boy he worked as a printer, then as a telegrapher, and in the meantime read all the useful books he could get hold of. When he was only seventeen years old he made his first important invention, another soon followed and this brought him a large sum of money. From that time to the present he has been constantly working and inventing, and experimenting, except when prevented by sickness. He has patented more than 700 of his inventions and has made many more which have received no patents.

Among his remarkable inventions are various telegraphic machines, the megaphone, the phonograph, the aerophone, the incandescent lamp, the kinetoscope, and the storage battery. His ambition is not only to develop electrical apparatus but to build comfortable concrete houses at low cost, and to organize automatic stores for groceries and other necessities in which almost everything will be done by machinery and therefore at the lowest possible cost. Not only has he made all these wonderful inventions and improvements but he is able to give occupation to thousands of men and women and enable them to get a living and develop what may be in them. What a grand privilege this is, and should not every boy have an ambition to be as nearly like Edison in usefulness as he can be?

Remember, too, that though Edison has accomplished all these mighty results he continues to work, often harder and more hours per day than any of his men. Some people think that brilliant men, whom we call men of genius, have an easy time and do their work without effort. Hear what Edison says on this matter, and remember it if you can! "Genius is two per cent. inspiration, and ninety-eight per cent. perspiration." If we cannot all be as great and as useful as Edison, we can at least put the ninety-eight per cent. of perspiration into our work and do the best we can.

Another man whose life was eminently successful and worthy to be held up as an example, showing the value of life, was Peter Cooper. He, too, was a poor boy and had a hard struggle in his early life. For many years he devoted his attention to the manufacture of glue, then in addition to the manufacture of iron, making many discoveries and improvements in both these industries. After he had acquired a large fortune, instead of using it for his selfish enjoyment, his ambition was to found an institution of learning where the children of the poor, and young working men and working women, could obtain advantages for scientific education which he had so earnestly desired when he was a boy, but could not have. He founded the Cooper Institute and endowed it with sufficient money to provide full instruction in night schools for all who desired to accept it. Many thousands of men and women have by this means obtained a good start in life through the benevolence of this good man.

Another successful American worthy to be remembered, starting from poverty, was Benjamin Franklin, one of the most sincere patriots of the American Revolution, and first to discover the electricity in the atmosphere, the father of the American postal system, and the originator of many useful inventions.

Others whom it would be well for you to read about are Charles Goodyear, who, after many unsuccessful experiments, finally succeeded in learning how to use India rubber in a great variety of ways, but especially to vulcanize or harden it which has permitted its use in a thousand different ways; Samuel F. B. Morse who, after years of patient effort, invented the electric telegraph; Bell, who made of the telephone the convenient instrument which we use every hour of the day, and hundreds of others, Americans and men of other nationalities, who have made the world a better place to live in by the way in which they used their brain and their hands.

In the foregoing remarks I have given you a little information concerning some Americans who have "made good" in life, and have made it better and more desirable by their efforts. Now let me tell you in a very few words something about an Englishman who also worked very hard and accomplished a great deal and left a name and reputation which will long be cherished. I doubt whether most of those who read these lines have ever heard of him though he was one of the best friends that English children, especially poor children, ever had. Unlike most of the Americans whom I told you about this man came into life with everything that is usually considered desirable. He belonged to a noble family, his ancestors for more than a hundred and fifty years being earls of England; he was rich so that every wish could be gratified; his name stood for great usefulness among the people, his opportunities for education were of the best, for there is nothing better than Oxford. His name was Anthony Ashley Cooper and his title was Earl of Shaftesbury. He was born in 1801 and died in 1885. He became a member of Parliament in 1826 and for the sixty years which followed he was chiefly occupied, both in public and private life, in steady and untiring work, whose only object was to make life easier for poor people who lived by their daily earnings. It was principally through his efforts that the reforms were obtained in the hours and work of women and children who worked in the English factories. The hours of work were reduced, night work was prohibited, hours for young children were made easier, and they were given a better chance to live and grow than they had ever had before. Then he had Parliament pass laws reforming the work in the mines, children under ten and women being no longer allowed to work in them. You can hardly realize the opposition he had in getting these laws passed and enforced.

Strange, is it not that greedy men care so little for the sufferings of women and children if only they can turn their health and strength into money for their own pockets. Going among the poor of London and finding the difficulty that the children had in getting even the simplest education, he founded and sustained the so-called Ragged Schools and for forty years was president of the organization that maintained them. This is but a small portion of the work which this great and good man did but it is enough to show you that he left England a far better place to live and work in than it was when he came to it.

CHAPTER IV.

Beginning Our Life in the World.

IN the previous chapters, I have told my young readers, in a general way, something about Life; what it is; how it grows and develops; how important it is, and what great things are done because of its presence in the world. Now one of the most interesting things and one of the most important for us to understand is how this wonderful thing we call Life begins.

FATHER AND MOTHER.

When we think of living beings coming into the world we naturally think also of those who were responsible for their coming. The idea of a child is necessarily connected with the idea of parents,—of father and mother. The ancients have a beautiful story that one of their best loved goddesses, Minerva by name, was not born in the usual way, but came forth full-grown from the head of her father Jupiter.

The story goes that one day, for some cause or other, Jupiter had a very severe pain in his head. It kept getting worse until at length his head burst open and out came a beautiful girl, fully dressed, with a helmet on her head and a spear in her hand. Because she came from the brain of the chief of all the gods she represented the idea of wisdom. She was, indeed, the patron saint, as it were, of the famous Greek city of Athens, and her name in the Greek language is practically the same as the name of the city.

Nobody ever heard of human beings or animals being born in that way so we must locate this story entirely within the realm of the imagination.

PLANTS, FLOWERS, BIRDS, AND INSECTS HAVE MOTHER AND FATHER.

We do not think of plants as having parents and yet with very many of them there is a male and a female element which must be brought in contact before a new plant can be born. The male and the female elements may be in plants which are removed from each other by a considerable distance and there may seem to be no possibility of their meeting each other, but kindly nature will often solve that problem in a very beautiful and effective way. Sometimes she persuades the wind to waft the necessary dust-like material or pollen from the male plant or flower to the female which is waiting to receive it and the result, when the conditions are favorable, will be a new plant and flower the following season. Sometimes she persuades a bee which has crawled into a male flower in search of honey to carry some of the pollen upon his back to the female flower when he crawls into it on a similar errand.

It is not quite true that all animals have father and mother, for in some of the insects, even those as high in the scale of life as the bees, the offspring are born from one sex alone. In the very great majority of animals, however, there is a male and a female, a father and a mother.

HOW INTERESTING IS AN EGG!

In animals above the insects, in the scale of life, and in very many of the insects the idea of offspring, or children, is also associated with the idea of an egg. In a general way it may be said that every animal comes from an egg, and it is therefore proper to associate the idea of the beginning of life with an egg.

Now what is an egg?

In the mind of young people it is usually associated with a bird, perhaps with a hen. They also think of it as food or as something to be eaten.

THE CARES OF MATERNITY.

For the present we will try and forget that it is an article of food which we have on our table almost every day, and think, instead, that it is the thing or object from which life begins.

HOW AN EGG IS CONSTRUCTED.

When it is laid by a hen we recognize it as a thing or substance with curved outline somewhat longer than wide, small at one end and gradually swelling out and reaching its greatest width near the upper end. Outwardly it has a covering or shell which is composed principally of lime. This shell is porous permitting the air to pass into it, which is one reason why some eggs are not as fresh as others. It does not get this hard covering until a short time before it leaves the body of the hen.

When it first leaves the organ in which it is made, which is called the ovary, its covering is soft and membranous like the covering of a turtle's egg. Within the shell is first a membrane or skin which covers the entire interior of the shell. At the large end of the egg is a small compartment or air-chamber. On the inner side of this air-chamber is another membrane which also extends entirely around the shell and is in contact with the membrane above-mentioned *except at the air-chamber.*

Then comes a thick layer of sticky, gluey, substance called *albumen,* or *the white.* This surrounds a spherical yellow lump or mass called the yolk which is held together and separated from the white by a membrane which surrounds it. From each end of this membrane a twisted thread or film of albumen goes to join the membrane which passes around the inside of the egg, the two threads steadying the yolk or holding it in place. Under the membrane of the yolk are several thin layers of albumen, parallel to each other and holding between them the yellow substance of the yolk.

Near the center of the yolk is another mass or lump of albumen shaped like a bottle with its top near the outer surface of the yolk, and on the top of this bottle-shaped lump is a small white speck which is the most important part of the whole egg. This is called the germ-disk and here it is that life in the hen's egg begins. This speck divides and subdivides and grows until at length a fully developed chicken has been formed which is then ready to break the shell and come out into the world.

HOW A CHICKEN IS FED BEFORE IT COMES FROM THE EGG.

While the different parts of the chicken were growing within the shell, life was sustained by the white and yellow albumen by which it was surrounded. A developing chicken has no other means of nourishment, no other supply of food but that which is within the shell. That is probably the reason why animals, including birds, reptiles, and some others whose young are developed outside of the body of the mother, have eggs which are so much larger than the eggs of those animals whose young are developed within the body of the mother.

THE EGGS OF MAMMALS.

The eggs of all mammalian animals which include all those in which the mothers nourish their young from their breasts are all very small, most of them being of about the same size whether the animal is large or small. In human beings the egg is about 1-125 of an inch in diameter, too small to be seen with the naked eye.

The eggs of mammalian animals are all constructed on one general plan, and it does not differ very much from the construction of the hen's egg. The outer covering or membrane (vitelline membrane) is not hard; within it is some sticky albuminous material (vitellus) corresponding to the white in the hen's egg. Within this is a minute sac (germinative vesicle) corresponding to the yolk, and within this a minute speck (germinative spot) corresponding to the germ-disk, in which, also, life begins.

The eggs of all animals are made or developed in a little organ called the ovary, or egg receptacle, and in the higher animals, at least, each female has two ovaries, one on either side of the body.

When an egg is sufficiently ripe to leave the ovary, a small lump or swelling is formed which bursts and the egg drops out, somewhat as a ripe chestnut burr opens and allows the chestnuts to drop out. It is then picked up by a tube or duct which pushes it along its channel until it reaches the organ where development begins, as a bird's egg drops from the bird into the nest.

HOW THE ANIMAL LEAVES THE EGG.

Within this nest the egg becomes attached or fastened and here the animal grows, one part of its body after another being formed and fashioned until it is ready to begin its existence in the great world outside of the body of its mother. Just as a pear or an apple that is ripe becomes detached from the tree and falls to the ground, so an animal or a human being that has become mature in its first stage of life is pushed out of its nest and into the world, there to begin the second period of its existence.

BEGINNING OUR LIFE IN THE WORLD.

When a human being comes into the world it finds conditions very different from those by which it was previously surrounded. It has eyes but they have never opened and they were developed in the darkness. It has a nose but the sense of smell is not developed, ears but no developed sense of hearing. It has a mouth but it has never been opened to take food, or anything else, all its nourishment being obtained through the connection between its body and the body of its mother, the blood of the mother flowing through suitable tubes or vessels into the growing vessels of the child and back again into those of the mother.

It has lungs but it has never used them for there was no need of them, and it did not breathe the air as you do. Its heart is pumping and its nervous system is working, for its blood flows, and it has the sense of feeling and the power of motion. It has been living where the temperature was nearly 100°F. and you will recall that the hottest days in summer are seldom as hot as that. Imagine now a being like that suddenly thrust into a place where the temperature is about 70°F., where there is light all around, and sounds and odors to which it must get accustomed. As the air of the atmosphere touches it, the signal is given for the lungs to expand and it gives a gasp and then begins to cry. This is usually its first salute to the world which it has entered.

The crying sets the breathing machine in motion, but it is sometimes several minutes or even hours before the lungs act in a proper manner, expanding as they fill with air, like a child's balloon when it is blown up, and collapsing or flattening out as the air leaves them, again like the balloon.

If the child doesn't breathe regularly after a few minutes have passed, those who are attending it begin to get anxious, and try to find the cause of the trouble and remove it. The lives of many children are saved by this care and watchfulness during the first few hours which follow birth. Many others who do not have such care die, and this emphasizes the importance of seeing that a new-born infant breathes regularly as soon after birth as possible.

If the infant is placed where the light is strong it will be observed that the eyelids are not widely opened at first, and there is often more or less sticky material adhering to them. Frequently it will be observed that the infant is winking, which means two things, first that it is already trying to use the muscles of its eyelids and, second, that it is trying to shade its eyes from the light which is too strong for them.

This is not an evidence that the child is beginning to use its brain, but is what is called a reflex act, the winking being the result of the stimulation of certain nerves connected with the sight apparatus by the rays of light. Very often it happens that the baby's eyelids have disease germs upon them which may lead to very serious trouble. Thousands of babies who are said to have been born blind are not blind when born but become blind after a few days.

Instead, therefore, of taking the chances that the baby will have no trouble with its eyes, the careful doctor always allows a few drops of a suitable medicine to fall into each eye, destroying any germs which may be there, and doing no harm if none are there.

In this way we can feel sure that the sight of a great many infants has been saved. The skin of a new-born baby is very tender, it can be torn almost as easily as tissue paper. It is covered with a greasy substance which is intended to protect it, and this must not be rubbed off harshly. It is better to wait a few hours before bathing the child, and by that time the grease will be dry and will come away readily.

Of course, the water of the bath must be warm, but not warm enough to burn the skin, and a fine soft sponge should be used for rubbing it. Many infants are injured by harshness in rubbing and sometimes by using soap that is too strong; then the mother or the nurse wonders why the child cries so much and has sores upon its skin, the trouble being really due to ignorance or carelessness in bathing.

CHAPTER V.

Life During Childhood and Youth.

THOSE who have travelled along some of our old country roads, especially those which were called post-roads, will remember that at the end of each mile there was a post of stone or wood with figures upon it indicating the number of miles from the starting point. These were called mile-stones and each one indicated that a certain portion of the distance from the starting point to the goal had been passed or accomplished.

Life is a journey. In the last chapter we were passing through the first stage or mile of that journey. We have now come to the period which measures off the second stage or mile and brings us to the second milestone. The period of your infancy, of absolute dependence and helplessness is passed. You no longer creep nor seek support from chair or table, but stand upright, without assistance and walk or run from place to place and object to object as inclination leads you.

HOW WE CHANGE AS WE GROW OLDER.

A little later, as your muscles get stronger and you gain confidence in using them, you begin to dance. Dancing implies a much more complicated use of muscles than walking or even running, and with you as a child is often the expression of your joy and happiness in living. If we had time we might tell of the important part which dancing plays in human experience, how ancient the custom is, how often it has formed a part of religious ceremony, how it is an expression of a great variety of emotions, how it is used among savages and people of limited intelligence to express what to them are very important and significant feelings, and how among people of greater intelligence it is a means of great amusement and pleasure. As it is practiced by professional men and women in the theatre it is often one of the cleverest exhibitions of the training to which the muscles can be subjected. But when you dance, as a little child, you do it more or less unconsciously without any thought of the new muscles which are being brought into action, or how you are strengthening and preparing them for more important uses.

With the increase in the size and strength of your muscles come other changes, your bones are getting larger and stronger, you are getting taller and increasing in weight. A very important fact at this period of your growth is the condition of the teeth. At first they appeared only in the front of your mouth, so that you could bite soft substances which didn't require much chewing, then others appeared at the sides so that you could bite harder substances, and finally came the back teeth which enable you to grind and reduce to a pulp the food which has been bitten off with the front and side teeth. Now, too, the salivary glands which supply saliva or spittle to the mouth begin to play their part in the preparation of your food. There are five of these glands, one under the tongue, one on each side of the lower jaw and one under each ear. When the food is chewed each one of these glands pours out the saliva which it contains, moistening the food and helping to dissolve it. If it were not for the saliva, chewing would be a much harder task than it is, and much more disagreeable. The saliva also contains a substance called ptyalin which helps digest the food, changing some of the substances which are composed mainly of starch (like potatoes) into sugar and so beginning the work of digestion.

At this period of life your stomach and intestines, too, increase in size and become able to handle the food which is brought to them as they could not do when you were a baby. Remember that the food must all be dissolved into a fluid state before it can be taken up into the blood and distributed to all portions of the body for their nourishment. The stomach makes two substances which are used in the digestion of a portion of the food which is received into it; these are mucus or slime, a slippery material, and gastric juice which is a kind of acid or sour material. The mucus is mixed with the food making it softer and enabling it to glide back and forth in the stomach, as a well-oiled piston moves along the inside of a cylinder. The gastric juice cuts or dissolves meat and other similar substances. The entire mass of soft, partially digested food is squeezed and churned by the stomach and then forced into the intestine.

Now comes the action of the liver and pancreas upon the soft and partly fluid mass of food. Each of these organs, like the stomach, has its own particular kind of juice. The bile dilutes the food and the pancreatic juice cuts and dissolves starchy foods and fats. Then there are thousands of little glands or pockets in the intestine which add their juice to complete the changing of the food into a fluid condition. We shall say more about these things when we describe the work of each of these organs in another chapter.

When the food has reached this completely digested condition it is sucked up by the open mouths of the thousands of little projections which line the wall of the intestine, like water that is sucked up by a sponge, and at length it reaches the blood on its final mission to nourish the body. All this your digestive organs are now able to perform but they could not do it so perfectly when you were a baby. In other words, as you have grown, there has also been an increase in the power of your digestive organs to do their work.

A very important sign of growth is also seen in your power to control the actions of the bowels and bladder. As a baby you had no such power, but now the reservoirs of waste material which is collected in these organs are more or less under the control of your will, and as your intelligence increases you learn to regulate their action.

As time goes on there comes a change in your countenance. It expresses a variety of emotions; if you are frightened, if you are sad, if you are joyful, if you are ashamed, these emotions can all be read in your face as they could not on the face of a baby. Your brain is increasing in size and activity, you now build houses with your blocks, rejoice in a train of cars, arrange your toy soldiers in companies, all of which require mental action. You also develop peculiarities which have been handed down by your parents and grandparents, you may show an affectionate disposition, or have fits of anger, perhaps like your father you show a great fondness for animals, or like your mother you may show great timidity, fear of bugs and mice and caterpillars, perhaps you show a strain of cruelty and enjoy mutilating insects and teasing cats and dogs. When you were a baby you slept the greater part of the time. Now you are awake and active the greater part of the day, sleeping for perhaps an hour or two, and usually tired enough to go to bed early and sleep all night.

DANGER OF DISEASE.

This period of life is characteristic in its sensitiveness to certain forms of disease which are often spoken of as children's diseases. It must not be supposed that they do not attack older children or even grown people, but they are far less frequent among them than among children. A young child that is exposed to them almost always catches them; a grown person *may* catch them, but usually he does not. But there is one interesting fact about them that if you have once had them you seldom have them a second time. Your system or body has become proof against that particular kind of poison and this condition is called *immunity*. Probably it is for that reason that many parents express a wish that their children may have these diseases and thus be more or less safe from other attacks.

The principal diseases which are common to this period are mumps, measles, chicken pox, scarlet fever, whooping cough, croup, and diphtheria. There are plenty of other diseases which you can have but they are not so common as these and in very few households do the children grow up without having one or more of them.

Your parents now begin to think of putting you in school that your mind may be strengthened and that you may make a foundation of knowledge which will be necessary and useful to you in getting a living and in going about among your fellow-men. The government realizes the importance of this knowledge and so it builds schools in villages and cities and provides teachers for them so that every boy and girl may go to them and get knowledge. In our country this knowledge is as free as the air we breathe and no boy or girl need grow up without it unless prevented by sickness or some other great misfortune. The government is very wise in doing this for an educated boy or girl almost always makes a better citizen than one who grows up in ignorance. First comes the kindergarten, the A. B. C., and then the primary and other grades as fast as you are able to take them.

Now you begin to choose associates and playmates. You like Mary and John and seek their company and enjoy playing with them, while you don't care very much for Sarah and James. Sometimes your likes and dislikes in this respect are very strong. Human beings in this particular are like magnetized iron which draws some objects to it and pushes others away. As your mind unfolds like the unfolding of a bud in the spring you will begin to see that there are some things which you may do and others which you may not do. You may love mother and father, you may be kind to playmates, may learn your lessons, but you may not lie or cheat, or play truant; in other words, you are beginning to get knowledge that some things are right and other things are wrong, and this we call the awakening of the moral nature. By this time we may say that you have reached the third mile-stone or period in your life, and usually you will be six or seven years old when you arrive there.

THIRD PERIOD OF LIFE.

How interesting it is to watch the growth of a plant as it proceeds from the tiny seed to the little stalk with its twigs and leaves and then to the mature plant with its buds and flowers. More interesting still is it to watch the growing child with all the possibilities for the future. When you have reached the age of seven years your digestive organs are usually in condition to dispose of almost any kind of food which is offered to them. You must bear in mind that the digestive organs are the furnace in the human machine and the food which is put into them is the fuel. It must therefore be plain that there should be plenty of fuel, and of good quality in order to get the right amount of heat and other good results which the body requires.

You are doubtless well aware that healthy children at this period of life are usually blessed with fine appetites and it is wonderful how much food they can eat and enjoy and digest, and how seldom their digestive machinery gets out of order. Grown people cannot take half the liberties with these organs which children take. Less sleep too is demanded as life progresses. You go to bed later and get up later and all the day from morning till night you are busy with your games, your school, or your companionships. This is the time when every healthy boy loves to play ball, to go swimming, to wander in the forest, and parents and teachers should encourage this out-of-door life in every possible way for both girls and boys, for they are now laying the foundation for their future physical life. It is a good thing to be enthusiastic over baseball matches and boat races and football games and every other kind of physical exercise which when properly used strengthens and upbuilds the body.

Just as early childhood has its common diseases and ailments so does this period also have diseases which are quite common though not so common as those which were mentioned as the peculiar diseases of childhood. Such diseases are very apt to attack the nervous system. One of those which is well-known is commonly called St. Vitus' Dance and this and other diseases of this period must not be neglected by your parents from the foolish idea that you will outgrow them, for if not properly attended to they may result in a condition which will seriously affect your entire future. In this period the ordinary diseases of the nose and throat are also very common and should receive careful attention.

At this period also the sexual nature becomes prominent. It is known as the age of puberty and the boy and the girl are on the borderline which separates childhood from manhood and womanhood. This is an exceedingly important period and you ought not to be kept in ignorance concerning those great facts which have so much to do with your future welfare as a husband and father, a wife and mother. Parents and teachers have too often erred in not explaining these subjects, and children have often gone astray because they were ignorant where they should have been instructed and informed. The moral nature is also deepened and strengthened at this time. Religion appeals perhaps more strongly now than at any other period of life.

In your school life it will often be possible to predict at this time what your future occupation is to be.

You will be likely to exhibit a tendency or aptitude for certain kinds of work, to be dull or bright, your intellect is more or less well-developed, and in very many cases this boy will be picked out for a carpenter, an electrician, a farmer, and this girl for a teacher, a typewriter, a dressmaker, etc.

From the age of 13 to that of 16 physical growth is rapid, both outside and inside. With the exception of the brain the organs of the body have reached their maturity, and in the normal case they are not likely to do any better than they are doing at that time. The maximum of height is reached, you will see many children who shoot up like a stalk in a few months, the bones lengthening with great rapidity. Then comes the period of filling out, the muscles get larger and firmer, fat is deposited in the various hollow spaces, and the body, instead of being lean and lank, shows gradually developing curves. Of course, with all these changes, you will also increase in weight, your countenance will become more mature, your voice deepens and your beard will begin to grow.

CAUTIONS.

Parents and teachers and friends can not be too considerate in their regard for the welfare of those who have reached this period. As they have passed through the period themselves they know what the dangers are. Their advice may be rejected for no one desires warning less than the one who has never known danger. You should especially be cautioned about the danger of straining and overtraining in athletic sports. Many athletes are short-lived, many others live with the discomfort and disturbance which attend weakened hearts, lungs, and kidneys. Especially is there danger to young athletes from injury to the heart. How can it be otherwise when we consider the strain that is so often put upon it in a closely contested football game or boat race. Does this mean that young men should not enter into such contests? It certainly means that there are many who should not and that there is a great element of risk for all who enter them.

If you are an ambitious boy or girl you must also guard against overwork at school. Many a boy or girl has worked hard to gain a prize in school, or to finish a particular course of study, only to have a physical breakdown when the contest was over. It must be recognized that there are some tasks which are too hard for some people, and if your teachers made themselves more conversant with the physical conditions of their pupils, they would save them much pain and suffering even at the expense of present disappointment.

Neither should the physical strain which comes upon those who are obliged to work long hours by day or by night in mills, shops, offices and factories be forgotten. Happily there is a fine sentiment forming against imposing such burdens upon those who are immature physically and mentally. The State should interfere because those who have been weakened by the heavy burden of toil during the growing period cannot make vigorous and useful citizens.

Finally, the sensitiveness of boys and girls to good and bad influences at this period should stimulate all good people to throw around the young every safeguard which will help in preparing for the serious duties of mature life.

CHAPTER VI.

Cell Structure in its Relation to the Body.

WE now come to what is, in many respects, the most interesting part of our entire story, because it brings us down to the beginnings of things in animals and plants, but especially in human beings.

EVERY HUMAN BEING ORIGINATES FROM A CELL.

Our entire body is made up of cells. Perhaps you will recall the statements which were made in the chapter which told you about the structure and development of the egg. The egg is one kind of a cell. There are many animals and plants whose entire structure consists of but one cell, and a very small one too, too small to be seen by the unaided eye. When one of these cells reaches a certain point in its history, it divides and becomes two cells, two animals or two plants, and the new cell is soon ready to divide again, and carry forward the life history.

The human body on the other hand is made up of untold millions of cells of various kinds constantly being born and growing, and as constantly decaying, dying, and being removed. It was not possible to discover the animal cell until the microscope had been invented and sufficiently improved to detect very minute objects, for remember that most cells are too small to be seen without a magnifying glass.

It is less than a hundred years since a German by the name of Theodor Schwann made the discovery that the cell was the starting point of all animal structure and described the mode of origin of the various tissues of the body from cells. There are many who are of the opinion that this was the most important of all the many important discoveries which have been made with the microscope. Schwann was therefore the father of the great fact that life develops from a cell; *histogenesis* is the word which expresses this idea.

The cell is the most important element in animal and vegetable life, it is a living thing, a physiological and anatomical unit. It takes in substances which nourish it and sometimes those which do not nourish it; it may take in substances which destroy it. It also gives out substances which are the product of its work or function, also substances which are worn out and of no further use to it. It grows, it changes, it may be transformed into a cell of a different shape. It may cohere or stick to other cells, or it may be firmly embedded in a mass of material somewhat as flies become attached to fly paper. It may be the parent of other cells and these may be produced in a variety of ways, and the process of production may take only a few minutes.

But perhaps you will say I am ahead of my story and that I haven't yet told you what a cell is like. You know what a honey bee is, and you know that it gathers honey, and that it stores it in what is known as honeycomb. You have probably seen a honeycomb and know that it is composed of a great number of little receptacles or chambers, closely fastened together, each of the same hexagonal or six-sided shape, and of the same size, twenty-nine to the square inch, and concave on the bottom. These little receptacles may be called cells and will give you an idea of what a cell is.

Now the simplest form of a cell is that of a sphere or ball, that is, if it stood alone, uninfluenced by surrounding cells, it would take that shape, like the shape of the globe on which we are living. Its shape can be changed in various ways, and this change is the result of pressure. When cells are in contact, as they are in a honeycomb, the pressure changes the outline from that of a sphere to that of a body with six sides. When cells are pressed upon evenly, at top and bottom, they are flattened and the outline becomes that of a circle. When cells press upon each other at the sides, the spherical form is changed to one which narrows to a point at each end and bulges in the middle. When the pressure is greater at one end than at the other, we get a triangular-shaped body with the base above and the apex below. When there is unequal pressure at different points, we get a body which is stellate or star-shaped with prongs or processes. Other shapes may also be produced, but those which we have mentioned are the principal ones. And every one of them may be found in the cells which make up different portions of the body.

Again comparing the cell to the egg, it may be said that every complete cell consists of a membrane or envelope which encloses a certain quantity of food material, albumen, fat, or mineral salts, or all combined, with a little spherical body at one side or one end called the *nucleus* and within the *nucleus* a minute speck called the *nucleolus*.

If a cell is thus complete, it is probable that it will produce another cell by the growth, first, from the nucleolus which draws its nourishment from the nucleus. Then this new being bursts from the nucleus and draws its nourishment from the body of the cell. From there it bursts through the membrane of the cell and begins its existence as a new cell. The old cell being no longer of any use, shrivels up, is dissolved, and is carried away by the lymphatic current which, as we shall see by and by, bears away the waste materials of the body to the blood from which they are carried out of the body by way of the kidneys, the lungs, or the skin.

Not all of the cells of the body are as complete as the type which has been mentioned. Some cells have no nucleus nor nucleolus, in others the food substance, or *protoplasm* as it is usually called by scientific writers, is deficient in quantity or in quality, and there are very many which have no enveloping membrane. If the description which was given of the normal cell is correct and we can take that as the standard, all these other cells are in a certain sense, imperfect. Some of them have no power of begetting other cells, while others produce new cells by division and in various other ways.

Every portion of the body is composed of cells. Every portion of the structure of animals and plants is composed of cells or of material which is connected with cells. As I have already stated, there are different kinds of cells in different parts of the body, varying with the work which they have to do and the conditions by which they are surrounded.

DIFFERENT VARIETIES OF CELLS AND THEIR ARRANGEMENT IN THE BODY.

There are as many different kinds of cells as there are different kinds of tissue; bone, muscle, nerve, blood, mucous membrane, cartilage, etc. Each cell belongs with its own class or kind and would not grow, as a rule, if transplanted to some other tissue. Of course it would be impossible, as well as unnecessary, in a work of this kind to describe all the different varieties of cells, but some of them can be described so that at least you may get an idea as to how they look.

The bone cells are oval in shape with short prongs projecting from them at many points, with an oval nucleus in the middle, and without any other covering or membrane.

The muscle cells, when fully developed, are long bands or strips coming to a point at each end and gradually swelling out toward the middle. Some of them have a nucleus, some have none, and some have several; a membrane or envelope surrounds them. The peculiarity of these cells is that they are elastic and will stretch out and shorten like a band of India rubber. It is this elastic quality of muscle which enables us to move the various parts of the body.

The nerve cells are very peculiar in appearance, some of them looking like spiders with prongs projecting from all parts of the cell body. Other cells are oval in shape, without prongs. Some have one nucleus and some more than one. Some have an enveloping membrane, and some have none.

The blood cells are in some respects the most interesting in the body. There are two varieties, red and white. The red cells, when seen from the front, resemble little rings. They are usually seen from the side and often occur in rolls or clumps like rolls of coin. The white cells are larger than the red, usually have several nuclei from which red cells are born, and often have a peculiar motion called amœboid movement, because it resembles the movement of the minute form of cell life called an *amœba.* The white cells when in motion look like little insects and stretch out little prongs or feelers as they roll along.

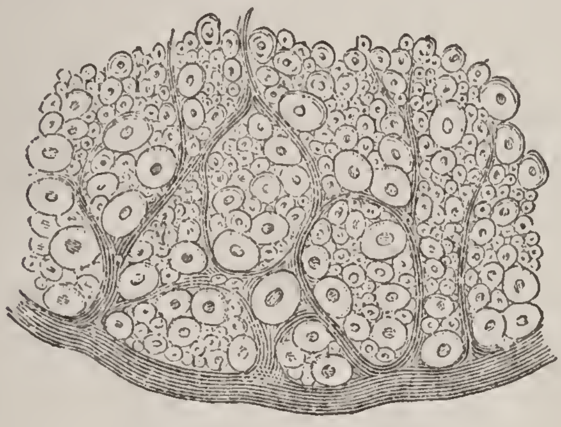
The cells of mucous membrane are of different sizes and shapes. Some of them are round and some of them triangular or cylindrical with the base of the triangle uppermost. Some of them have a row of little prongs or bristles along the base, which have a waving motion backward and forward.

Let us now see how these cells are arranged in the different parts of the body, and we will take only a few examples. The blood cells are immersed in that wonderful fluid called the blood which is also sometimes called a tissue probably because it is made up of so many different elements. The blood is always in motion during life and health, hence if we examine the blood current in a living animal under the microscope (the web of a frog's foot furnishes a good specimen for making such an observation) we shall see rolls and clumps and individual red cells tumbling over each other, of different sizes, and resembling a ring, a biscuit, a dumb-bell or a plate according to the angle of observation. Among them will occasionally be seen a white blood cell, for the red are many times more numerous than the white. They are easily recognized for they are larger than the red, are spherical or round in appearance, have a number of small bodies, or nuclei, within them, and as they roll along throw out their processes like the feelers of an insect, as if they were on the lookout for their prey, which in many instances seems really to be the fact.

Of course if all the cells in the body were arranged like the blood cells there could be no firm tissues, and hence no solid bodies. Let us next look at the arrangement of the cartilage cells, the cartilage or gristle being the elastic substance which is placed like a pad between the ends of bones to bear the resistance when the ends are brought suddenly and forcibly together. The cells of cartilage are round, oval, or flat, without a membrane, and with a well-marked nucleus. They are embedded but not very closely together in a sticky substance or glue. The cells are relatively far less numerous than the cells of the blood, but on the other hand the cartilage is a solid tissue and the blood is not.

Take another kind of cells, the cylindrical or triangular. They are placed side by side, with the base uppermost and are used as the lining of certain canals or channels in the body. Of course the cells which adjoin each other are not in contact at all points, and these intervals are filled by a kind of cement which binds them together and makes a firm tissue. Again, take the muscle cells; a great number of these are stuck together with a kind of cement into a little bundle or fasciculus, several bundles are joined together forming a larger bundle, and the larger bundles into a firm mass which makes an entire muscle. In muscular tissue there is less cement or intermediate substance than in the tissue made of cylindrical cells, and far less than in cartilage.

Finally, take the round flat cells such as are in the skin and the mucous membrane; these are laid closely together, layer upon layer, with comparatively little cement substance to hold them together. Thus all the different tissues of the body are made up with cells for their principal material and the substance which holds the cells together for the remainder. There are other structures, too, which form a part of the cellular tissues, namely, blood-vessels, lymphatics, nerves, and glands, for these are some of the means by which life is sustained in the tissues and consequently in the cells themselves.


Arrangement of Round Cells.

It is very interesting to observe the behavior of certain cells when a part of the body is injured. Suppose a small cut is received; there is bleeding but in a short time the bleeding stops, the cut being filled with what is commonly called a clot. When the blood-vessel was opened, kindly nature furnished a material the object of which is to thicken the blood, making a plug with the thickened material and the cells and so stop the bleeding. Again, when a bone is broken, nature at once throws a wall of cells and other material around the ends and attempts to cement them together. This material is poured out in great abundance and is called *callus*. It makes one think of boys rushing to a fire from all directions, eager to put the fire out. This benevolence on the part of nature in her attempt to repair injuries has long been observed and the ancients gave it the name of *the medicative force of nature.*

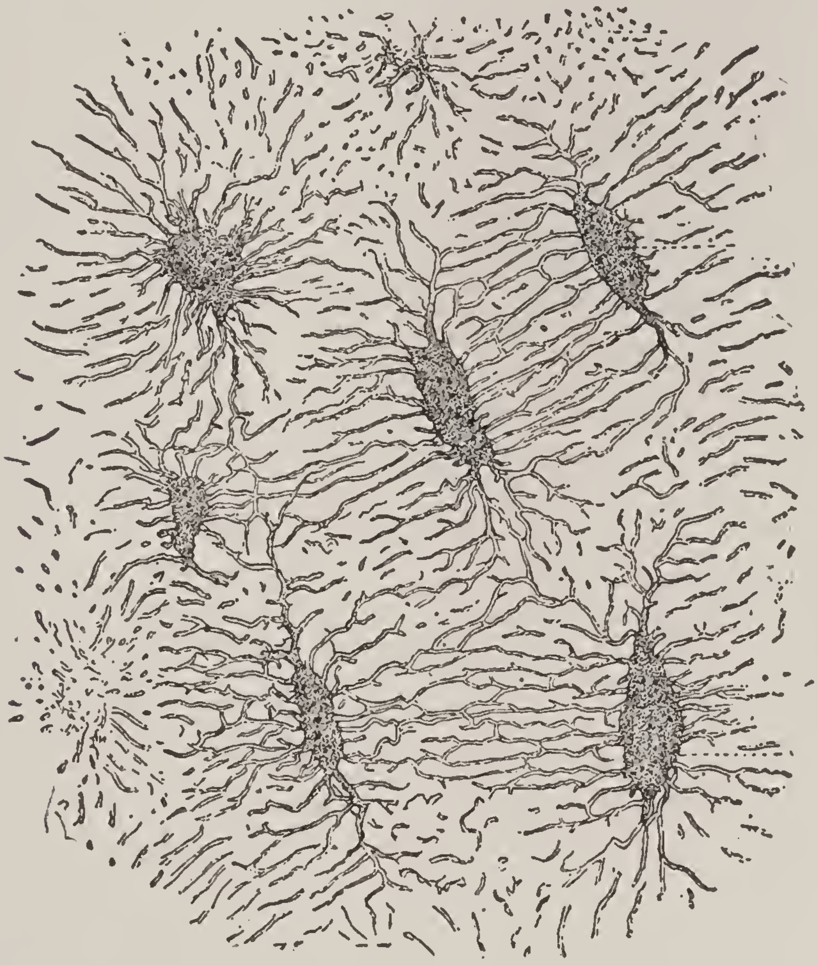
The cells also play a very important part in disease. Suppose a part becomes inflamed, a finger, for example. It becomes, hot, red, painful, and swollen, and if you could look under the skin you would see that the surrounding blood-vessels had emptied thousands of white blood cells into the tissue and thus caused the swelling. So in the formation of tumors we usually have a great accumulation of cells, sometimes in places where they should be and sometimes where they should not be. The cells may either be normal cells in too great abundance, or they may be imperfect cells which increase and decay with great rapidity, and as they increase may push aside and destroy surrounding tissues. A bony tumor may be merely an unusually large number of bone cells and may be harmless, or it may be bone cells plus other kinds of cells and be very dangerous to life. A fatty tumor may be merely a large collection of fat cells, perhaps in a place where they do not belong. A cancerous tumor is made up of cells which multiply and decay with great rapidity, penetrate surrounding tissues and cause destruction of everything which comes in their path.

WHAT BECOMES OF THE CELLS OF THE BODY.

What becomes of the leaves and bark upon the trees? After they have matured they fall off and decay and are dissolved. If you bury a pile of leaves in the earth and look for them in a year or two you will find that they have entirely disappeared. So with the cells. They are born, they develop, they do their work, then they decay and are dissolved, and the little tubes called lymphatics bear away their remains to the blood which takes them to the skin, the lungs and the kidneys by which they are conveyed out of the body as waste.

Let us take a specific instance of the removal of cells from the body, the finger nails, for example. They are constantly growing and when they reach a certain length we trim them. If you soften one of these trimmings and look at it under the microscope you will find it composed of cells and intermediate substance like the other tissues. Again, suppose one washes the hands with soap and water and then scrubs them with a brush. If the water be then examined it will be found to contain a great quantity of cells which were removed with the brush.

This shedding of the cells of the skin is constantly going on, sometimes they can even be seen as fine scales, and this is particularly the case after such a disease as scarlet fever when the entire outer covering of the skin may peel off. The tongue is another portion of the body where constant friction and rasping are constantly removing the cells from its surface. If the tongue were scraped with a dull knife it would be easy to remove a quantity of cells which could then be examined and identified with a magnifying glass. The eye is also constantly shedding the cells from the mucous membrane which covers it. This is particularly the case if the moisture which is usually supplied to it is wanting. When the discharge from the eye is abundant many cells of mucus or pus may be found in the discharge, while the cells of the mucous membrane


Bone Cells.

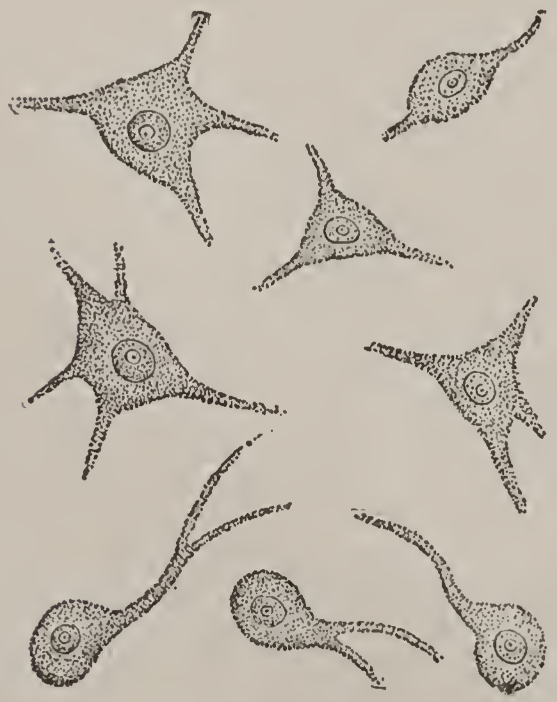
covering the eye may be dissolved in the discharge and conveyed through the tear duct into the nose from which they are removed from the body.

The cells or the tissues within the body undergo the same process of change and decay as those on the outside; they are dissolved, they are carried away by the lymphatic current, they pass into the blood, and are finally swept away through the skin, lungs, and kidneys.

WORK WHICH THE CELLS HAVE TO PERFORM.

As there is a great variety of cells in the body so there is a great variety of work which they have to do. Some cells appear to be simply for protection; the hard cells of the palm of the hand protect the underlying tissues from bruising and other injuries. The cells of the mucous membrane manufacture the sticky, slimy substance called mucus; the cells of the liver make bile, and the cells in the different digestive organs make the digestive juices, each cell contributing its portion, however small that may be.

Thus it will be seen that they all lead a busy life, each one doing the work which belongs to it, and contributing its share to the total output. This is true whether the cells belong to the human body, to animals, or to plants. The lesson of the cells is therefore a very important one; it shows us that industry is the object of their existence. Some do their work well, and others do it badly, and the structure, as a whole, thrives or fails to thrive according as these humble but important servants act the part that is assigned to them by nature.



Nerve Cells.

PART II.

The Structure of the Body, or the Way it is Put Together and the Parts of which it is Composed.

CHAPTER VII.

Substances of which the Body is Composed.

A WONDERFUL MACHINE.

THE human body is not a single substance, like a bar of iron. If you break a bar of iron at any point whatsoever you will find iron, and nothing else, all the way through. Neither is it altogether like a steam engine, though it resembles it in some respects. If you take the engine apart you will have a pile of pieces of iron, and steel, and brass, possibly a little wood, covered with oil and grease, and paint, and that is about all. You can count almost on the fingers of one hand all the substances of which this machine is composed.

But the human machine is very different and very much more complicated in its make-up and I am going to tell you just what substances enter into it so that if you were to take it entirely apart you could identify and label each of these substances. Work of this kind is called laboratory work, it does not consist merely in cutting or slicing, or breaking, or chopping up the body as you would break the iron bar, or as you would break up the steam engine, but in subjecting it to certain tests with which chemists are entirely familiar which enable them, by means of certain signs or rules, to distinguish one object or substance from another.

If you should visit the National Museum in Washington you would find displayed in one of the cases a number of jars each labeled with the substance which it is said to contain. Near these jars, another label or placard informs you that these are the substances which were obtained from a human body weighing 154 pounds. Of course these substances do not weigh that amount, for in the laboratory process by which they were obtained and by which the body was broken up much of the 154 pounds disappeared in gas or vapor, and the small amount of solid substance in the jars was all that remained after this chemical operation was finished.

These substances which are to be found in every human body which is made normally or as it ought to be made are called proximate or elemental principles, which we may understand as meaning that they cannot be divided up into any other substances. There are about sixty of such substances which can be found and taken out of the different parts of the body. (Exceptions are *Diastase* and *Chlorophylle* which are found only in plants). They may be divided into five groups or classes, each group or class having its own particular peculiarity.

SUBSTANCES WHICH COMPOSE THE BODY.

The first class is composed of substances which may be found outside the body in much the same form as within the body. These substances are called inorganic and have no life in them at any time or place. The second class includes substances which may be found both in animals and plants, that is, in things which have life and are formed outside of the human body, and also of substances which are formed within the body. The third class which, in some respects, is the most important of all also includes substances which are found both in plants and animals but much more abundantly in animals than in plants. They are called proteids or albuminoids, which means that all of them have more or less resemblance to albumen, and you will remember that the simplest form of albumen is that which is found in the white of an egg. The fourth class is not a large one and includes the few substances which give color to various structures. One of them is found in the greatest abundance in plants, the others are found in the fluids of the body, both in animals and in human beings. The fifth class contains colorless substances which resemble those of the third class or albuminoids, but differing from them in the fact that if they are examined under the microscope they will be found to be made up of crystals, while the albuminoids are not.

Now let us look a little more closely into this matter and see what these various substances are like. In the first class we can go anywhere in the world and pick up substances which belong to it. The most important of them is *Water* about which I may have some very interesting statements to make by and by. Water, which is so common in every part of the world, is also the commonest, most abundant thing in the human body. If you should squeeze every drop of it out of the human body, taking away everything that was combined with it, and divide the whole amount, solid and fluid, into ten parts, water would represent seven of those parts; that is, seven-tenths of the body, by weight, is composed of *Water*.

Another substance in this class which is very important is *Salt* which is found in all the fluids and tissues of the body and is taken into the body not only in the form in which it is sprinkled upon the food but as an essential part of different vegetables, such as potatoes, beets, turnips, cabbages, oats, peas, and beans. Even more important than *Salt* are the combinations of *Lime* (the phosphate and the carbonate), for without these and other mineral combinations the bones would be soft and unable to support the body. There is more *lime* in the body than any other mineral substance, and its quantity is next, in abundance, to water. More than half of the bony tissues is made of *Lime,* and it is also present in the teeth, the cartilage, the milk, the blood, the bile, and the urine. It is taken into the body by means of the food, and there are very few of the food substances which we ordinarily eat which do not contain it.

Almost always there is associated with the *Lime* another mineral called *Magnesium* (phosphate and carbonate). There is not so much of this in the bones as there is of lime, but there is more of it in the muscles and the brain. There are other minerals which are found in the body which are taken into it with the food most of them being combinations of soda or potash. It will not be necessary to trouble you by describing them.

It may be added that there are also several minerals which are found in the body in very small quantities: *Iron, Silica, Fluorine Manganese, Copper,* and *Lead.* Iron is the most important of these, and is always found in the blood of those who are in good health.

Of the substances of the second class or group the most important is *Starch.* It is found in all plants and seeds and is so abundant in certain plants which we call vegetables that it is gathered for food and becomes one of the necessities of life for human beings and animals. Corn, wheat, oats, rye, rice, potatoes, peas, and beans are composed principally of starch.

We shall see in another chapter how it is changed to *Sugar.* Sugar is also a very important substance of this class and is obtained both from plants and animals. There are three principal varieties known as *Grape Sugar* or *Glucose, Cane Sugar,* and *Milk Sugar,* according to the source from which they are obtained. But this substance is by no means obtained exclusively from grapes, sugar cane and milk, for in every variety of plant starch is changed into sugar before it can be used for the nutrition of the plant. Sugar is also found in the blood and in various juices of the body and in the disease which is known as *diabetes* the blood contains so much of it that death is very frequently the result. The form of sugar which is found in abundance in the liver in all human beings and in many varieties (vertebrates) of animals is called *Liver Sugar* or *Glycogen.* It is important to remember that all the starch foods which are taken into the body are first changed into *Glucose* or *Grape Sugar,* and are then carried in this form to the liver which takes away the water which the glucose contains and leaves *Glycogen* or *Liver Sugar* remaining. This is kept in the liver until it is needed for the nourishment of the body when it is changed back again into *Glucose* and carried by the blood to the part which requires it. The liver in this case is a furnace or laboratory which has this job or work to perform.

Another group of substances in this second class are the *Fats* or fatty substances. These are also found almost everywhere both in animals and plants. Is it not remarkable that substances of great importance which are found in animals are also found, or something which is very similar, in plants, as if there were one plan for the making and running of everything, or almost everything, which has life? There are three principal varieties of fats; that which is hard and solid, such as is found upon the bodies of animals we will call animal fat or *Stearine;* that which is semi-solid and is found especially in oil from the palm tree, but also in various animals and vegetables, is called *Palmitine,* while that which under ordinary circumstances is always fluid and oily is called *Oleine* or vegetable oil. Very good examples of the last mentioned oil are olive oil, cotton-seed oil, castor oil, etc. *Fat* is distributed over the entire body; it is not alone in the places where it acts as a pad or cushion, making a larger or smaller lump or mass, sometimes so large as to be unsightly and disfiguring, but it is in the various organs of the body, in the glands of the skin, in the milk, and in the marrow of the bones, and can be separated from any of these substances in one or other of the three above mentioned forms. It serves not only to keep the body warm, as in places where it is in thick layers, but it is also useful as a means of nourishment. When one is recovering from a severe sickness, the fatty layers of the body have usually disappeared and we say such a person is thin or emaciated. The explanation of this is that the fat has been used as a kind of fuel during the sickness. In the same way animals which sleep during the entire winter are very thin when they awake in the spring for they have been living, so to speak, on their Fat.

There is but one other substance of this class in the human body, which resembles fat but is not, and is called *Cholesterine.* It is found principally in the bile which, as you know, is the juice which is made by the liver, but it is also found in the skin, the blood, the spleen, the eye, the nerves, the spinal cord, and the brain, and in various tumors and discharges of the body.

The third class of substances is, as I have said, the most important in many respects of all of them. Some of them furnish important portions of the food which nourishes the body, while others digest the food, and still others are parts of the body structure itself; in other words, they may be divided into three groups. One of these substances is the *albumen of the blood* found in what is called the *serum* or watery portion of the blood. It is also found in several of the other fluids of the body, in addition to the blood. Similar to this substance is *egg albumen,* or the white of egg, an important article of food. Next comes *Caseine* or cheese which is obtained from milk and then two substances with long names which are found in the blood (*Paraglobuline* and *Fibrinogen*). After these comes a substance (*Myosine*) which is found in the muscles which gives them their peculiar power of contraction, that is, of shortening and lengthening, like India rubber. Finally in this group come *Syntonine* and *Peptone* which are the names given to all albuminous materials which have been taken into the stomach and digested by the gastric juice. The *Syntonine* is first produced and then when the ferment called *Pepsine* has acted upon it, the result is *Peptone,* and peptone can be absorbed or sucked up from the stomach as a sponge absorbs water, and be carried away by the blood.

Now comes the group of ferments of this class, ferments being the substances which digest the various kinds of food. The first of these is *Ptyaline* which is found in the saliva of the mouth and changes starch into sugar. Then comes Pepsine which is in the juice of the stomach and changes albuminous substances into Peptone. Then follow the *Pancreatic ferments* which are made in the pancreas or sweetbread, and digest starchy and fatty food, and albuminous foods also, but only to a slight degree. Another very important ferment is called *Diastase,* but this is found only in plants and it changes starch into sugar plus a soluble substance called Dextrine. It is *Diastase* which changes barley into malt in the manufacture of beer.

Then comes a very important substance called *Fibrine ferment* which causes the coagulation or clotting of the blood and therefore is very useful as a means of arresting troublesome haemorrhage.

The substances of the third group in this class are known as *Mucine, Gelatine, Chondrine, Elastine,* and *Keratine. Mucine* is the sticky substance in the mucus or slime which is made in the mucous membranes in different parts of the body; it keeps them slippery and prevents them from getting dry, just as oil which is applied to machinery makes it run smoothly. *Gelatine* is the glue which is obtained from bones, ligaments, tendons, etc. You know what an important substance it is to the cabinet-maker, and how useful it is in mending broken furniture. It is also used to make a very agreeable and nutritious article of food. *Chondrine* is a substance which is obtained from cartilage or gristle, as gelatine is obtained from bones. *Elastine* is obtained from the arteries and from some of the ligaments, and *Keratine* is the horny substance which is found in hair, feathers, and the outer layer of the skin.

In the fourth class the most important substance is one which is found in the blood and gives it its peculiar bright color. It is known as *Hæmoglobine*, and its remarkable properties are that it absorbs oxygen which the blood requires, and it also contains iron. People with colorless skin, pale people, do not have enough of this material in their blood while red-faced and red-skinned people have it in abundance. Another interesting color material is the dark substance which makes the skin dark or black. It is also found in dark hair, in the dark portion of the eye, and in tumors which are of a dark color. This is known as *Melanine.*

The bile which is made in the liver has two color substances, one gives it an orange-red color, and the other a green. The former is called *Bilirubine* and the latter *Biliverdine.* The yellow color which is characteristic of normal urine is due to a substance called *Urochrome.* Next to *Hæmoglobine* the most important color material is that which gives the beautiful green color to plants and is called *Chlorophylle.* It must not be forgotten that Chlorophylle in the plant cell acts with sunlight and the inorganic substances which plants find in the ground to form the organic substance *Starch* which is an all-important process in the life of every green plant. Chlorophylle plays a very important part in this performance. Some writers have said that Chlorophylle is to plants what Hæmoglobine is to animals. Remember this, that Hæmoglobine takes in oxygen which has been inhaled by the lungs from the air and that the Chlorophylle in green leaves and plants gives out oxygen to the air, so that each seems necessary to the other.

The fifth class contains substances which are important but are not of special interest to the general reader, and particularly to the young reader, and therefore I shall not weary you by describing them, but at the end of this chapter I have given you the names of all the substances which you may be interested in knowing.

We have now noted briefly the various substances which enter into the composition of the human body. We have also seen that many of them are to be found in the structure of animals and plants, and that there seems to be a kind of relationship between the one and the other, as if one, in a long process of time, longer than we can imagine, might have grown out of the other. But I do not say that this is so, because I do not know, only there does seem a remarkable similarity about many of the things which are common to plants and animals.

HOW THE MATERIALS OF THE BODY ARE PUT TOGETHER.

The question now very naturally arises how do all these substances get into the body, or how is the body put together? Of course in the developing infant, before birth, the only means which it has of getting nourishment is through its attachment to its mother. Blood passes from one to the other through suitable channels or vessels, and out of the mother's blood are taken the materials which the child requires, new blood vessels and new supplies of blood being furnished as each part grows and demands more nourishment. After the child is born and for a number of months afterward its only means of nourishment is milk with the possible addition of some vegetable material like wheat, barley, oats, or arrow root. These therefore must contain all the substances which go to build up the body, they are the fuel which supplies it with heat and enables the different machines to transform them into the necessary materials which are the means for producing growth.

As we grow and approach maturity, new substances, and in greater quantity are taken into the body, and these are treated by the body machinery and converted into the materials of which the body is composed at that period and so on. The materials therefore which compose the structure of the body are not rolled together as a snowball is rolled up or as an apothecary rolls up different kinds of medicine into one mass or lump, but they are the result of laboratory work, material of a certain kind being supplied to the laboratory and the laboratory machinery breaking it up into its parts, and sending each of these parts by way of the blood current, to that portion of the body which needs it. It is somewhat as it is with the waters of a river in the spring; they are loaded with melted snow, mud, driftwood, etc. They overflow the meadow land, and when the earth absorbs the water, the mud and other material remain on the surface. Part of this must be removed, while another part remains and makes the land more fertile and fruitful. If we take the one substance—cow's milk and analyze it we see that it contains all the necessary elements for building up the body, for it has water and mineral salts of the first class, fat (butter) and sugar of the second class, and albuminous material (caseine) of the third class.

The substances of the fourth and fifth classes, as has already been stated, are made within the body. The additions to the body come, therefore, by means of various substances which are taken in and quickly absorbed, like water, by food which is partly digested and absorbed, and partly rejected as useless or harmful, and by miscellaneous substances which may pass through the body from one end to the other, without much change, or may undergo the same changes which food substances undergo. at the same time influencing the body for good or ill, in a more or less important manner, like the different kinds of medicine.

DO THE MATERIALS WHICH ARE TAKEN INTO THE BODY REMAIN THERE?

It ought to be plain from what has now been said that some of the materials which we take into the body remain there, at least for a long time, and some are transformed into or nourish the living tissues, which wear out and are cast off, to be renewed and replaced by others. Thus the lime which is taken into the body with water, milk, and various kinds of food, is greatly needed for the use of the bones, but when the bones have all they require a further supply is unnecessary, and if it continues to come, the body must, if possible, get rid of it. The water which we drink and which is a part of our food is very necessary, for the body is constantly getting rid of it through the lungs, the skin, the kidneys, and the intestines, and there is a constant demand for it by the blood and the various organs and tissues, but if we take more than is required, extra work is placed on the above mentioned organs to dispose of it, or it is squeezed into the tissues where it is not wanted and becomes a source of mischief.

Of the substances which are taken into the body which do not nourish it there are some of which a portion may be absorbed while the remainder does no particular harm and is discharged by one or another of the portions of the body devoted to that particular purpose. There are others, however, which do great harm either injuring or destroying the parts with which they come in contact or producing injurious changes in the blood, and in the organs to which the blood may carry them. A very good example of the first kind of substances is pulverized charcoal, which is sometimes taken to relieve indigestion. Most of it passes through the body and out by way of the intestine and is charcoal when it leaves the body. Small particles of it may be absorbed and stain tissues or juices with which they come in contact but no harm will result in any event. Substances of the second kind are known as poisons, and a good example of the first variety, or corrosive poisons, may be found in carbolic acid which destroys any living tissue with which it comes in contact and may produce death. An example of the second variety is a ptomaine such as may be obtained from fish, oysters, etc., which have begun to decompose.

(A ptomaine is a poison which is made by decomposition in living or dead tissues as the result of the action of bacteria. When such poisons are introduced into the body, they are absorbed by the blood, in which they increase and multiply and may cause serious sickness or even death).

To sum up the statements which have been made in this chapter we can compare the process of building the body to that which takes place in the building up or growth of a tree. The tree is placed, as a small sapling we will say, in the ground which is its home. Its roots draw moisture and mineral matter from the ground, while above the ground its leaves, which are its lungs, are exposed to the air and light. These resources are changed, within the body of the tree, into starch and sugar and other materials which are its food and cause the particles of which the tree is composed to increase and multiply, cell being added to cell. The tree increases in height, in the spread of its boughs, and in the size of its trunk; we have new bark, new wood, new leaves, and finally the complete or mature tree.

So in the human body which is planted in its home but which also moves about, air is taken into the lungs, the sunlight shines upon it, it has exercise to strengthen it, it has rest and sleep to refresh it. It takes within it the various substances which we have been telling you about, these are changed, when necessary, into simpler substances which can be taken up by the blood, and the blood carries them and deposits them wherever they are needed. Those parts which are worn out and which are unnecessary are thrown off or cast out of the body. Thus the cells of which the body is composed are fed, new cells are born and added to the others, and like the tree, the body spreads out and increases in height and weight until at length we have the mature and completed structure.

The following tables may be of service in giving at a glance a summary of the different substances referred to in the foregoing chapter.

Table of Substances composing the First Class or elemental principles.

Water.
Sodium Chloride (Salt).
Sodium Phosphate.
Sodium Bi-phosphate.
Sodium Sulphate.
Potassium Chloride.
Potassium Phosphate.
Potassium Sulphate.
Potassium Carbonate.
Lime Phosphate.
Lime Carbonate.
Magnesium Phosphate.
Magnesium Carbonate.
Iron.
Silica.
Fluorine.
Copper.
Manganese.
Lead.

Substances of the Second Class.

Starch.
Sugar (a) Glucose; (b) Milk Sugar; (c) Cane Sugar.
Glycogen.
Fat (a) Stearine; (b) Palmitine; (c) Oleine.
Cholesterine.

Substances of the Third Class.

Group I.—Blood-albumen, Egg-albumen, Casein; Paraglobuline, Fibrinogen, Myosine, Syntonine Peptone.
II.—Ptyaline, Pepsine, Pancreatin, Ferments, Fibrin, Ferment, Diastase.
III.—Mucine, Gelatine, Chondrine, Elastine, Keratine.

Substances of the Fourth Class.

Haemoglobine, Melanine, Bilirubine, Biliverdine, Urochrome, Chloraphylle.

Substances of the Fifth Class.

Lecithine, Cerebrine, Lencine, Tyrosene, Sodium Glychocholate, Sodium Taurocholate, Creatine, Creatinine, Urea, Sodium Urate, Sodium Hippurate.

CHAPTER VIII.

The Structure of the Body.

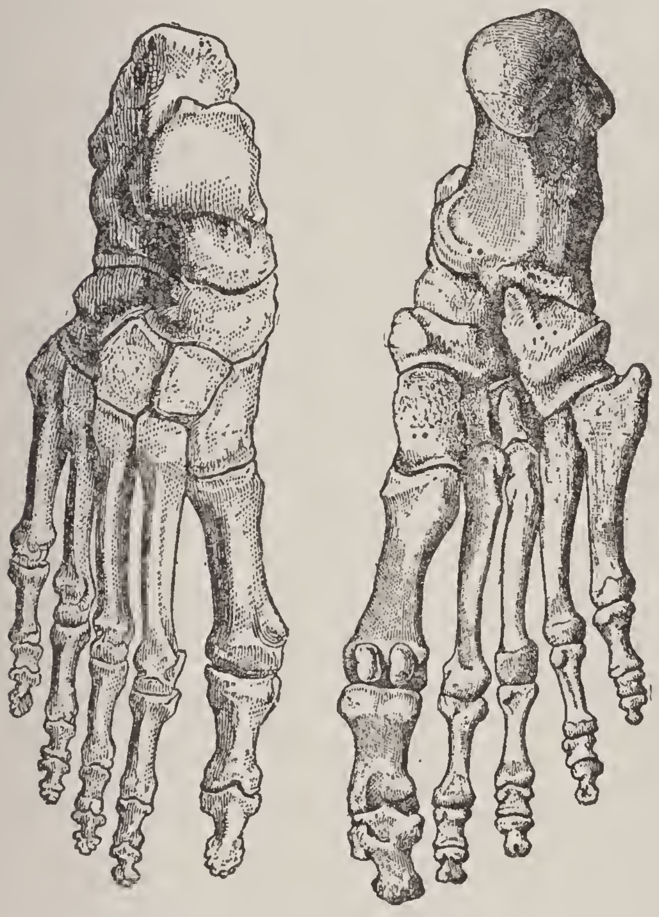
WHAT DO WE MEAN BY THE STRUCTURE OF THE BODY?

BY the structure of the body we mean the *different parts* of which it is made, not in this instance the minute elements or materials of which these parts are composed, about which I have already told you something, but the larger parts or pieces into which it can be divided, if you were to take it entirely apart, as you might take apart a steam engine or some other piece of machinery. You know that at the present time a great many buildings with steel frames are being erected, and as I have seen them going up, post after post, and beam after beam, followed by the coverings outside and the linings inside, and then by the machinery and apparatus which are used to finish them and make them places to live in and work in, it seemed to me that such buildings could very properly be compared with the structure of the human body and the way in which it is put together.

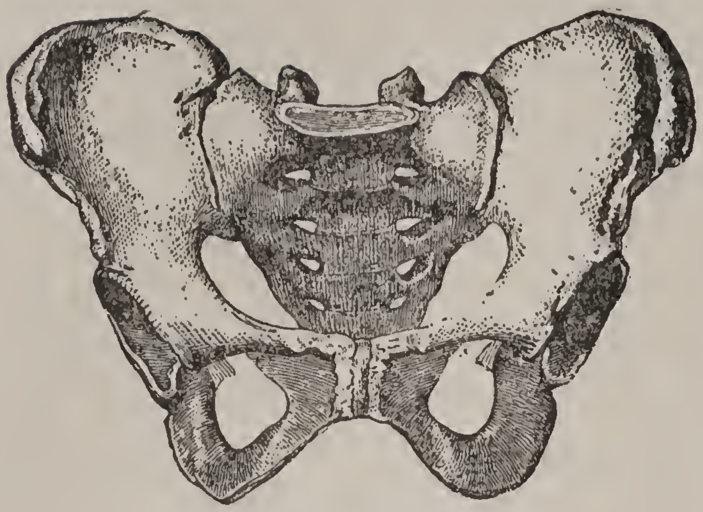
Let us see then, if we can, in what way the building up of the body is like the building up of the steel frame structure.

THE FRAMEWORK OF THE BUILDING.

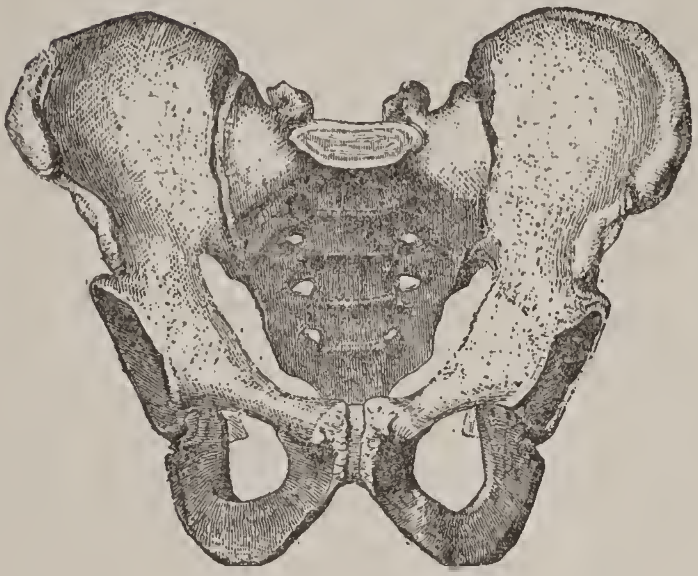
First, of course, comes the framework or skeleton of the body, like the framework of the building. This must be extremely strong for it carries the weight of the entire body and it is made of bone, the hardest and toughest substance in the body. You will remember that one-third of bone is composed of gelatin or glue, and the tissues which make up its blood-vessels while two-thirds are lime, and limestone is very hard and very tough. The steel frame building begins with a firm foundation and then is built up, story after story, until the top is reached. In like manner the human skeleton has for its foundation the strong solid bones of the feet, fifty-two in number, spread out to give the body good balance, like fifty-two blocks of limestone. Then come the long and strong bones of the lower extremities for the first story, two strong bones in each leg buttressed at the knee by a binding bone, and so attached above and below that they can move easily in different directions as you may choose to walk, stoop, kick or dance, for this house, unlike the steel frame building, is not fixed and stationary, but is capable of and is intended for all kinds of motion.


Lower Surface. Upper Surface.
Bones of the Feet.

Above these bones are the two thigh bones, the longest and in many respects the strongest bones in the body also firmly attached above and below, intended to bear the great weight of the structure above them, and with a strong piece at the top of each coming off at a sharp angle and keyed into the framework of the next story. This story takes a different form from the one below it, probably because it is to be devoted to an entirely different purpose. Its bones are strong and irregular; they are sometimes called the haunch bones, and by their coming together with the end of the backbone they form a cavity or hollow which is known as the pelvis or basin. This story and the two



Pelvis or Basin of Female.

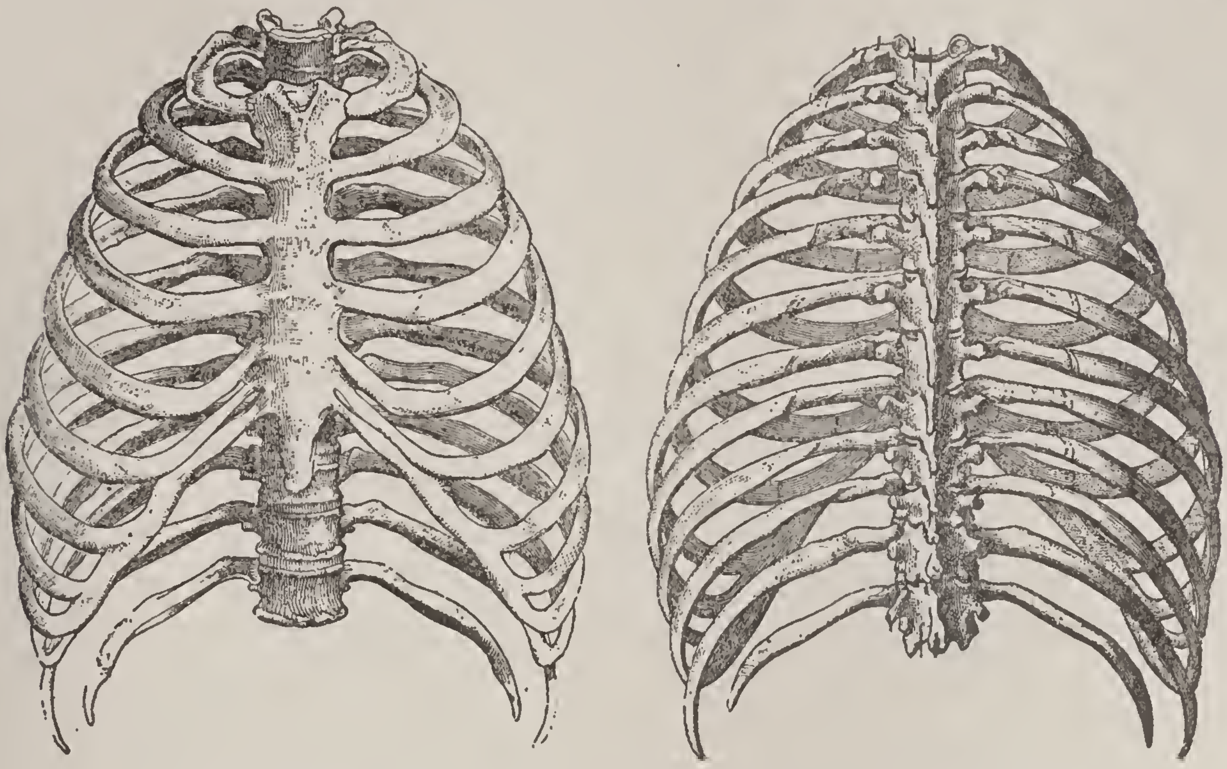


Pelvis or Basin of Male.

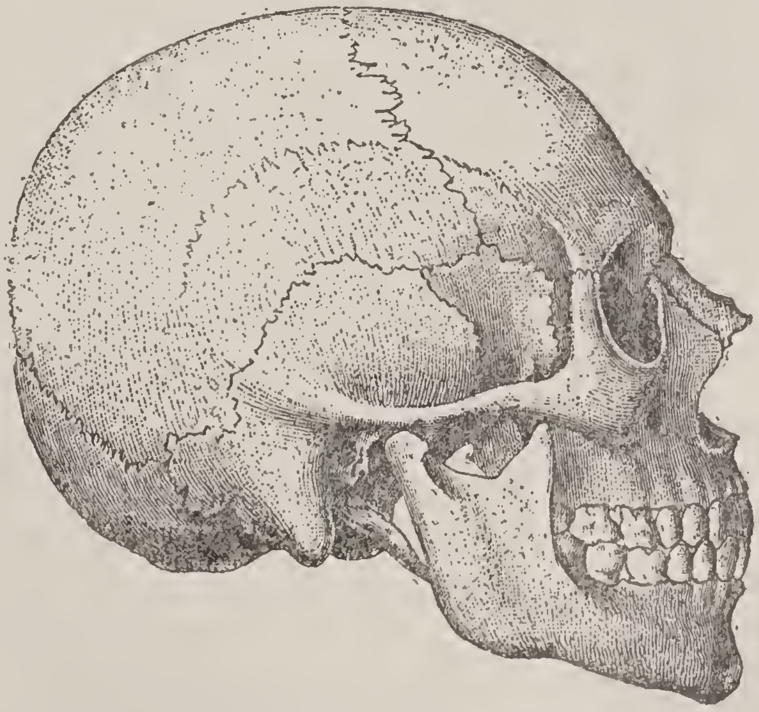
which are above it are especially important because they are to contain the organs or machinery by which the work of the body is performed.

The next story is the largest of all, is in appearance a kind of cage, is composed of the ribs, the breast bone, the backbone, the two collar bones, and the two shoulder blades. These bones, as you may see by examining a skeleton, are of varying shape and strength. The ribs are curved and easily broken if they receive a sharp blow. Others are straight or nearly so, like the breast bone, and the key bones or collar bones on each side of it, at the top. Up and down the back are the curious irregular bones which make the backbone or spine, so firmly fastened together that they can with difficulty be taken apart, and yet sufficiently movable to enable the body to turn in any direction. Running through them as they are strung together is a hole, or canal, which contains one of the most important structures of the body called the spinal cord. At each corner of the back of the cage is a curious triangular flat bone, tacked on as it were, and called the shoulder blade.

The fourth or top story, or cupola, is composed of the upper portion of the backbone and the skull. The skull is composed of very thick and strong bones, and it is well that this is so for they enclose what is in some respects the most important organ in the body, the brain, by which we are enabled to think, and so to get a living. The bones which are in the front of the skull or the face, and those which are within it are less



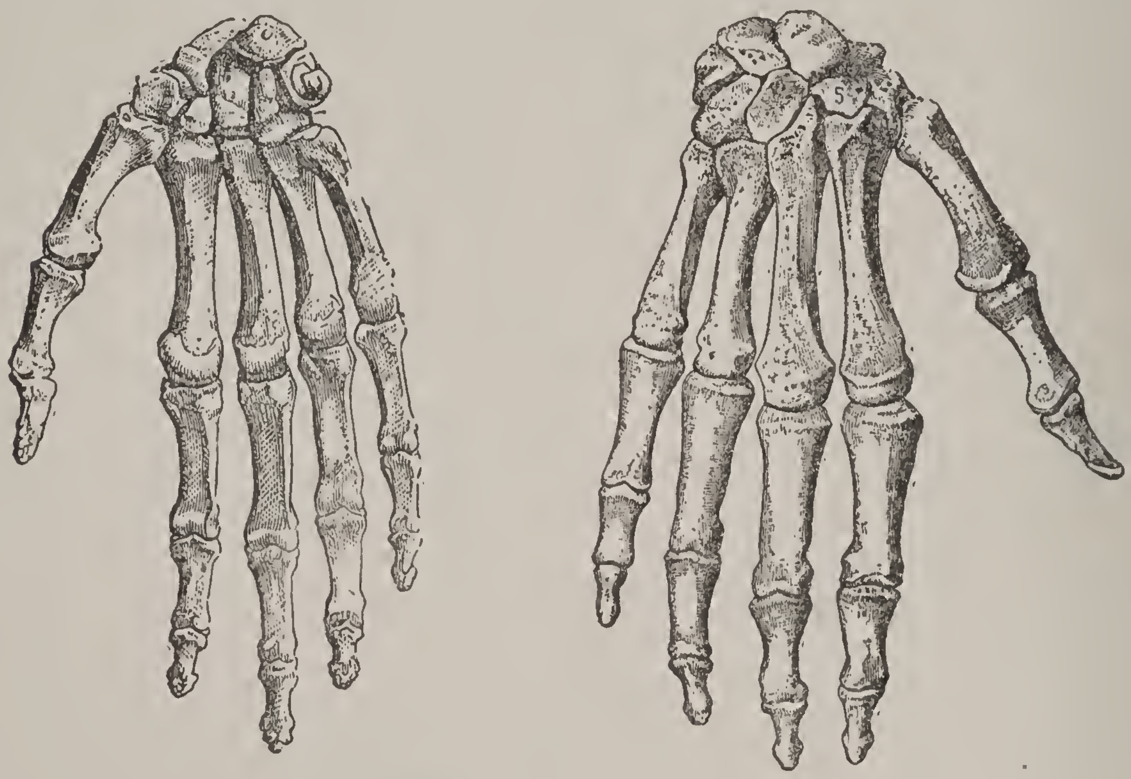
Front and rear views of the Ribs, Breastbone, and Backbone.



Side view of the Skull.

strong and more easily broken than the others, but they are so placed that they are protected by the strong and firmly united bones of the top and sides. With the exception of the lower jaw the bones of the head have no power of motion, they are rigidly joined together and can not usually be taken apart during life.

In addition to the four stories which we have imagined there is an annex on each side of the third, or cage-like story, and these are most important for without them there could be no handicraft; without them most of us would starve except as we were helped and fed by those who had them, and were disposed to take pity on us. What a beautiful arrangement we have in the bones of these annexes, for each is precisely like the other. The plan is very similar to the plan of the bones in the lower extremities, but the latter are made and placed for the particular purpose of sustaining weight and carrying the body about in its various undertakings while the former are intended to perform the various coarse, fine, simple, and complicated movements which make up the daily output of our lives. The upper bone in each of these combinations is keyed



Palm. Back.

Bones of the Hands.

to the triangular shoulder blade which forms a buttress on the back. Below this bone is a combination of two, as in the lower extremity, and beyond are the irregular bones of the wrist and the straight bones of the hand. Perhaps the most important of the bones of the hand are those of the thumb. It is the thumb which distinguishes the upper extremity in man from that in the lower animals. All these bones of the hand and wrist are wonderfully joined together permitting motion in all directions, and they are so adjusted that they can control and execute the terrible blow of the sledge hammer or the delicate manipulations which are made by the watchmaker.

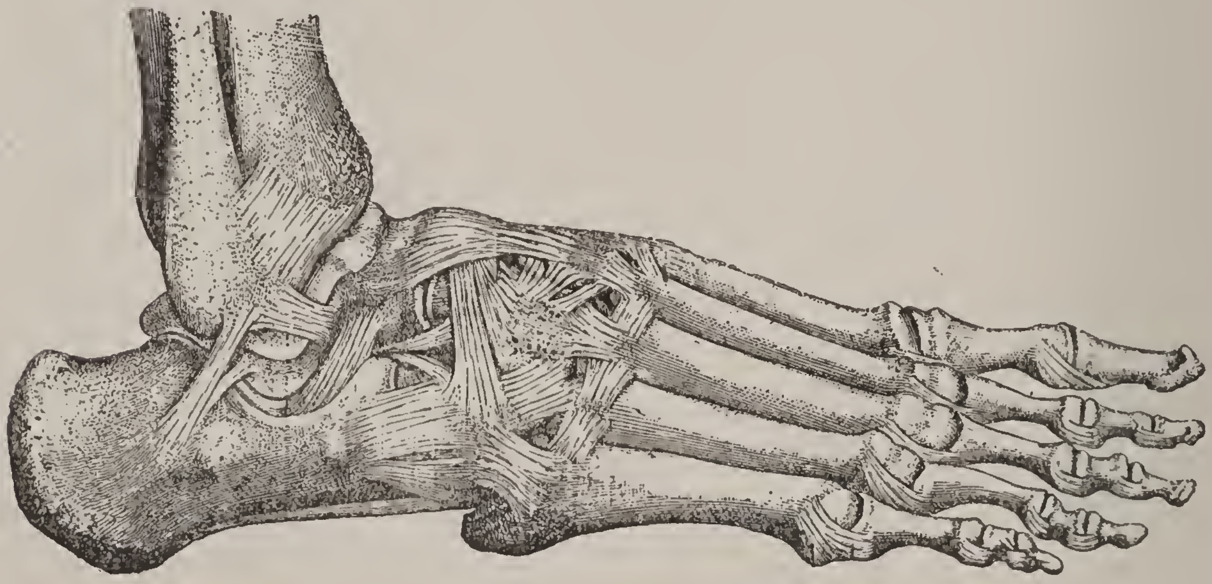
Do not forget that the bones are covered with a kind of skin or membrane (periosteum) which is a very important structure, for the life of the bone depends upon it and many of the cells of which the bone is composed come from this membrane. The entire number of bones in the body is two hundred, and they are of different kinds and shapes according to the work which they have to perform. There are the long bones which are constantly used for motion, like the bones of the legs and arms, and each of them has a hollow, or cavity, passing from the top to the bottom. There are short bones, short and thick, and of great strength but with little power of motion like the bones of the wrist. There are flat bones, which are for protection, or to furnish extensive surface for the attachment of muscles like the bones of the head, the ribs, etc. And finally, there are the irregular bones, like those in the spinal column or backbone, etc.

HOW THE BUILDING IS HELD TOGETHER.

On the steel frame where beams or posts come together, you will notice that steel bands or plates are riveted, and hold adjoining parts firmly together. In the skeleton there are similar bands where two bones come together, made of very strong elastic material, like a very tough skin, completely surrounding the ends of the bones, and holding them together. These are called ligaments.

HINGES, PADS, AND BUFFERS.

When it is desired, in a building, to swing one part upon another, as a door is swung open upon a door frame, a mechanical device called a hinge is used. This enables you to open or close the door, the movement being controlled by the hinge. Another form of motion which is sometimes used in buildings is produced by placing a bar or piece with an end like a ball into a groove or socket, in which it may move freely in all directions within a half circle. Still another form of motion is produced when two bodies or pieces are made to glide over each other, back and forth, and from side to side. Such movements are all produced also in the human skeleton, and when two bones come together and are bound by a ligament they form what is called a joint.



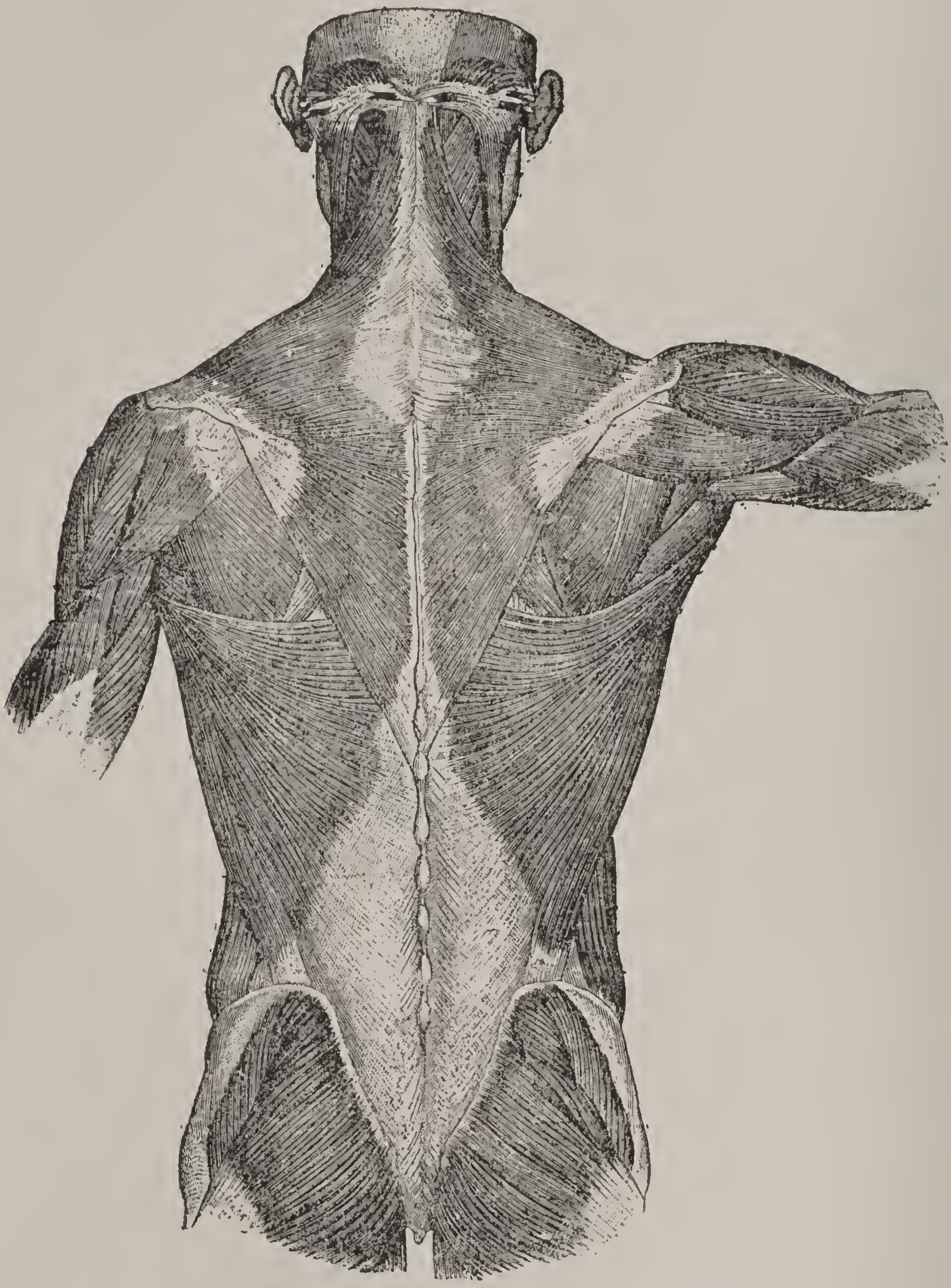
Ligaments and Hinge Joint at the Ankle.

Joints are in various parts of the body and produce the various forms of motion which were mentioned above. Thus the union of the bones of the lower extremity at the knee is called the knee joint, and the motion back and forth, like the swinging of a door, makes it a hinge joint. The union of the thigh bone with the pelvis, or haunch, is called the hip joint, and the rotary motion in all directions makes it a ball and socket joint. The gliding motion of two of the bones of the foot over each other makes this a gliding joint.

Another interesting point in regard to joints is the provision against injury which is made in them. If the ends of two bones came together forcibly and violently, in case of fall from a considerable height, for example, if they were unprotected the violence of the contact of the bones with each other would be liable to break them. Nature provides against this accident by placing on the ends of the bones a thick layer of elastic substance, like a pad of India rubber which is called cartilage or gristle. This cartilage takes up the force of the violent contact between the ends of the bones and so prevents injury to them. Of course this is sometimes so great that not even the cartilage will prevent the bones from being broken. Cartilage, then, which is always to be found on the ends of bones which are in contact with each other, takes the part of a buffer. A familiar example of a buffer is seen on the end of a railroad car. When two cars come together to be coupled they sometimes meet with great force and the cars and everything in them would be severely shaken if a buffer or strong spring were not connected with the coupler to act as cartilage acts in taking up the violence of the contact.

MUSCLES AND THEIR ARRANGEMENT AS A COVERING TO THE FRAMEWORK, SHEATHS, TENDONS, AND FASCIAE.

After the mechanics have put together the steel frame of a building, riveted the plates at the joints, and also put buffers in place at the joints, if any should be required, the next step will be to put the covering upon the building. There may be one layer of such a covering, or there may be several, one being laid upon the top of the other. If there are several layers the mechanics must be very particular to have each accurately placed in proper relations with the others.

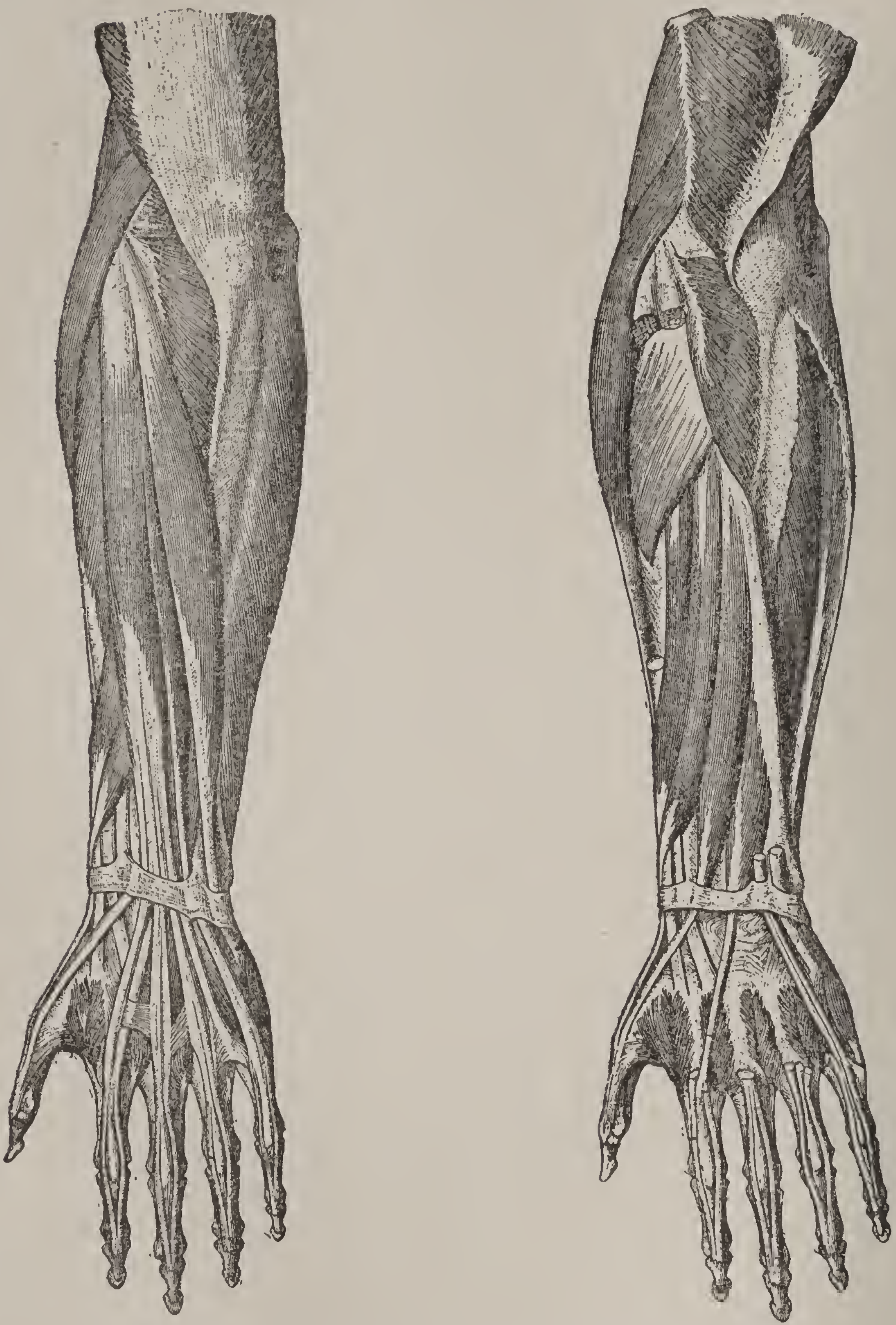


Arrangement of the Muscles of the Back and Shoulder; also showing Tendons and Fascia.

The human skeleton must also have its coverings, and these are laid, one upon the other, with far greater accuracy than any mechanic can lay the coverings upon the framework of a building.

The first covering which is applied to the skeleton is composed of the muscles. I told you in a previous chapter how a muscle is made up, how it is composed first of delicate fibers or cells bound together in little bundles, and these in larger bundles which are finally united in one compact mass. A very common shape for a muscle is that which tapers to a point at each end and bulges in the middle. It is nature's plan to protect every organ and part as efficiently as possible, and so most of the muscles are covered with a sheet of tough membrane, or skin, which is elastic enough to give with each movement of the muscle, but not thick enough to interfere with its motion; this covering is called its sheath. At each end of the muscle there is also a piece of firm gristly material called a tendon. One tendon is frequently, though not always, attached upon a suitable portion of bone at a point from which it can pull with the best mechanical advantage, and this point is called the origin of the muscle. The other tendon at the other extremity of the muscle is frequently attached to a bone at a point where it can best bear the resistance of the pull, and this point is called the insertion of the muscle. You can readily understand how much more power a muscle will have by the reënforcement of the tough tendons than if the ends themselves of the muscles were attached to the bone, for in the latter case any severe exertion would quickly tear the delicate fibers and separate them from their attachments. Some of the tendons are very short, and some, like those on the back of the hand, are very long.

Move the fingers of your hand forth and back and you can see the tendons stretching and relaxing under the skin. The muscles are applied, one layer upon another, but not with their fibers all running in the same direction for if they were applied in such a manner the number of motions which the body could make would be very limited. As a matter of fact the body as a whole, as well as its separate parts, can move in all directions, and therefore the muscles which



Muscles of the Back of the Hand and Arm with their Tendons.

supply the power of motion must also be laid in different directions, one muscle pulling up and down, another from side to side, another diagonally, and another in a rotatory or circular fashion. Another structure by which the muscles are strengthened and protected and assisted in their action is called the *fascia,* this being a Latin word which means a bandage and in this case refers to the binding action, which it has on the tissues by which it is surrounded. It is called also a fibrous membrane and is similar in texture to the sheath which covers a muscle. In some places it is very thin and in others very thick and tough. There are different layers or deposits of it, one of them is just under the skin and extends over almost the entire body; another lies more deeply under some of the muscles, but not in an even continuous layer like the one which is under the skin. Sometimes in eating a piece of lean roast beef you may have noticed a white stringy substance, hard to chew and much tougher than the rest of the meat. This white substance is *fascia,* while the red meat is muscle.

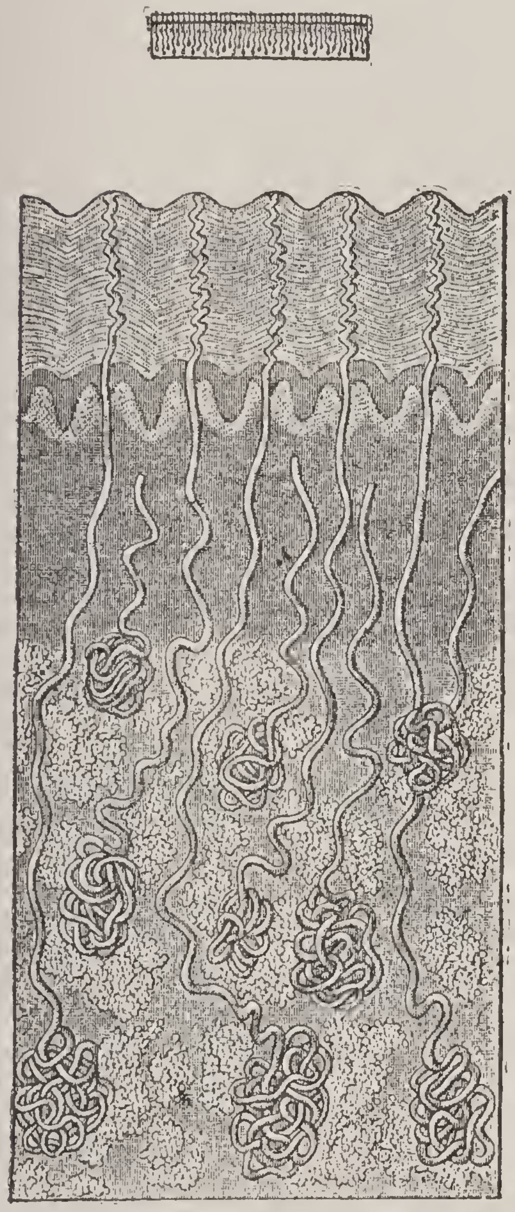
THE OUTER COVERING.

The layer of *fascia* which is under the skin has attachments to the skin and it is also connected in some parts of the body with the sheaths of muscles, which explains the fact that when certain muscles move or contract the skin moves also. It is in this layer of *fascia* also that the fat is deposited.

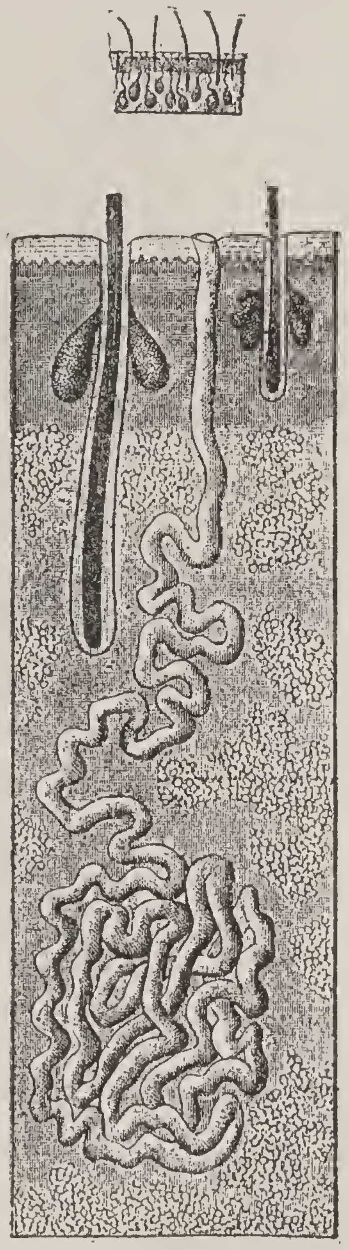
In a well developed person the fat is distributed over the entire body. In some places there is very little of it and in others the layer is a very thick one. Over the abdomen, or belly, it is sometimes several inches thick. Fat on the human body is not a thick hard substance, like the suet or tallow of animals, but is more like a thick liquid, like palm oil, and hence called palmitine, as I told you in a previous chapter. If you were to observe the blood from a fat person whose skin has been cut, you would notice drops of fat floating in the blood. Fat is the substance which nature uses for filling up cavities or hollows in the body, it is a sort of padding. Thus in the cavities in which the eyes are located there is such a padding, also in the hollow spaces under the arms, and in many other places. Fat adds very much to the attractiveness of the human figure, if there is not too much of it. A man or woman with well-rounded figure is a much pleasanter object to look at than one who is lean and emaciated.

Finally we come to the outermost layer or covering of the body, and this we call the skin. It is made up of two principal layers, the outer one hard and horny, and the inner one soft and very sensitive. How hard the outer layer may get is seen in the corns and warts which come upon the toes and fingers and are principally a collection of cells of this horny layer. The inner layer contains the ends of the nerves which make the skin the organ of touch or feeling. The skin may be very thin or very thick. Remember it is the skin of animals from which leather is made, and you know how thick leather may sometimes be. The skin is a very complicated structure for it not only contains the ends of nerves but it contains veins and arteries and capillaries and lymphatics and in addition the myriads of little glands in which the sweat or perspiration is made, ready to be poured out to keep the skin moist, and the almost equally important glands from which the hairs grow.

The importance of the hair as a covering for the body is often very great, especially in cold climates, which is the reason why nature gives animals in such climates a thick coat of hair which we call fur. Each hair starts from its root in the hair gland and grows upward and outward. As its end becomes worn off or is cut off it continues to grow to make good the loss. Near the root of the hair is a gland, or perhaps more than one, called a sebaceous gland, which makes a greasy, oily substance with which the hair and the skin around it are lubricated. If it were not for this substance the hair would be dry and brittle and would break easily as you may have seen it break in some persons. The material from the sebaceous gland is sometimes offensive in odor, as you may have noticed in persons with a greasy skin who are not particular about cleanliness.



Section of skin showing its different Layers and a series of Sweat Glands.

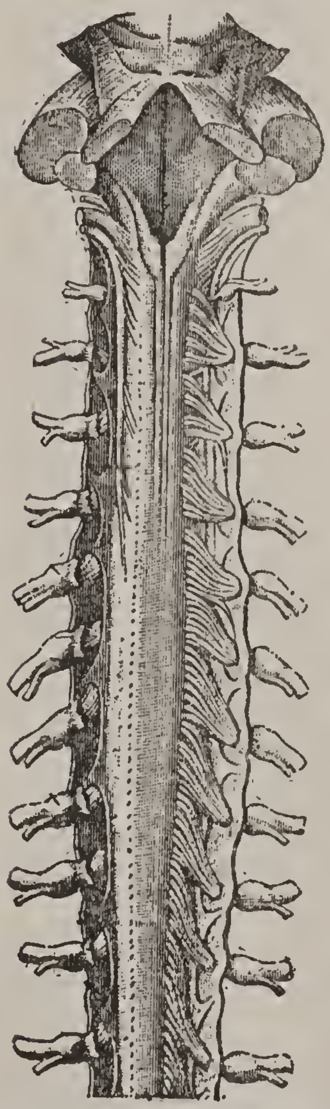


Section of Skin showing Hair Follicle Sebaceous Glands and Sweat Gland.

You have noticed that the skin of some persons is light while that of others is dark or even black. This is due to the coloring matter (melanine) which is in the skin, the more there is of this substance the darker will the skin be.

THE WIRES OF THE BODY.

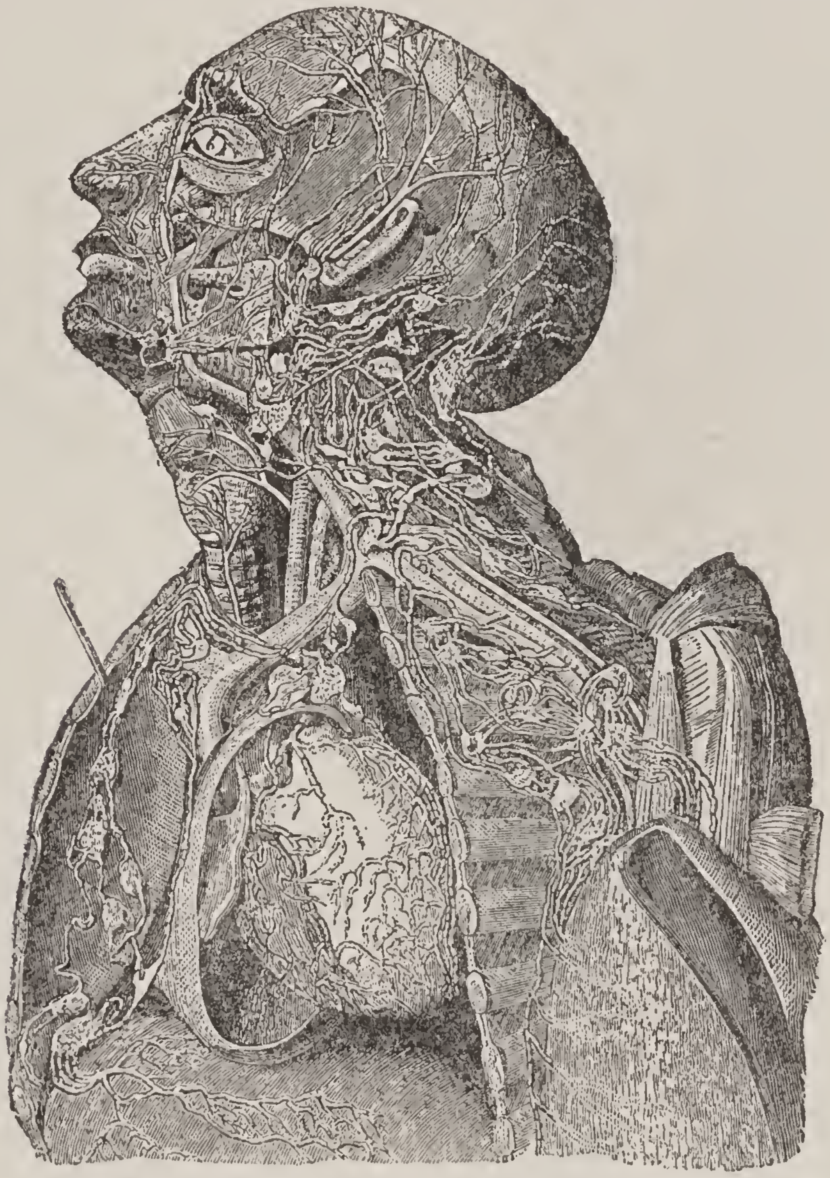
When the workmen have finished the outside of the steel frame building they turn their attention to the inside, where various appliances or furnishings may be introduced for necessity or for convenience. One of the first things which they place in the walls of the house is a system of wires for the distribution of the electric current to the lights, bells, and other useful appliances which are to be found in almost every modern up-to-date house. You know how quickly the current responds to pressure upon a button. It is often possible to light up every portion of a house by pressure upon just one button, so sensitive is the electric current to the control of suitable mechanical influences.



Lower Portion of Brain, Spinal Cord and Spinal Nerves, looking from the front.

Now in the body we have an apparatus called the nervous system which is as much like a system of electric wires as anything with which we are familiar. It is made up mainly of fibers or strings, like the electric wires, and cells such as we told you about in the chapter on cells. One part of it which we might call literally the headquarters is in the skull and comprises the different parts of the brain to which the other parts of the nervous system directly or indirectly point as their center.

From the brain, like a long tail, comes the spinal cord, which is placed in the cavity or canal in the backbone called the spinal canal. From the lower portion of the brain and from each side of the spinal cord, through suitable openings in the bones, come the nerves or cords or wires which are distributed to every portion of the body. These nerves, especially those which come from the spinal cord, are at first as thick as a small lead pencil, but the further they go and the more they are divided up the smaller they get, until at length when they get to the skin the most of them are so small that they can hardly be seen with the naked eye. The smaller the nerve the fewer the fibers or strings it is composed of, each fiber being smaller than fine cotton thread. When we reach the large nerves we find them composed of bundles of fibers as we told you the muscles were composed.



Nerves and Ganglia of the Sympathetic System.

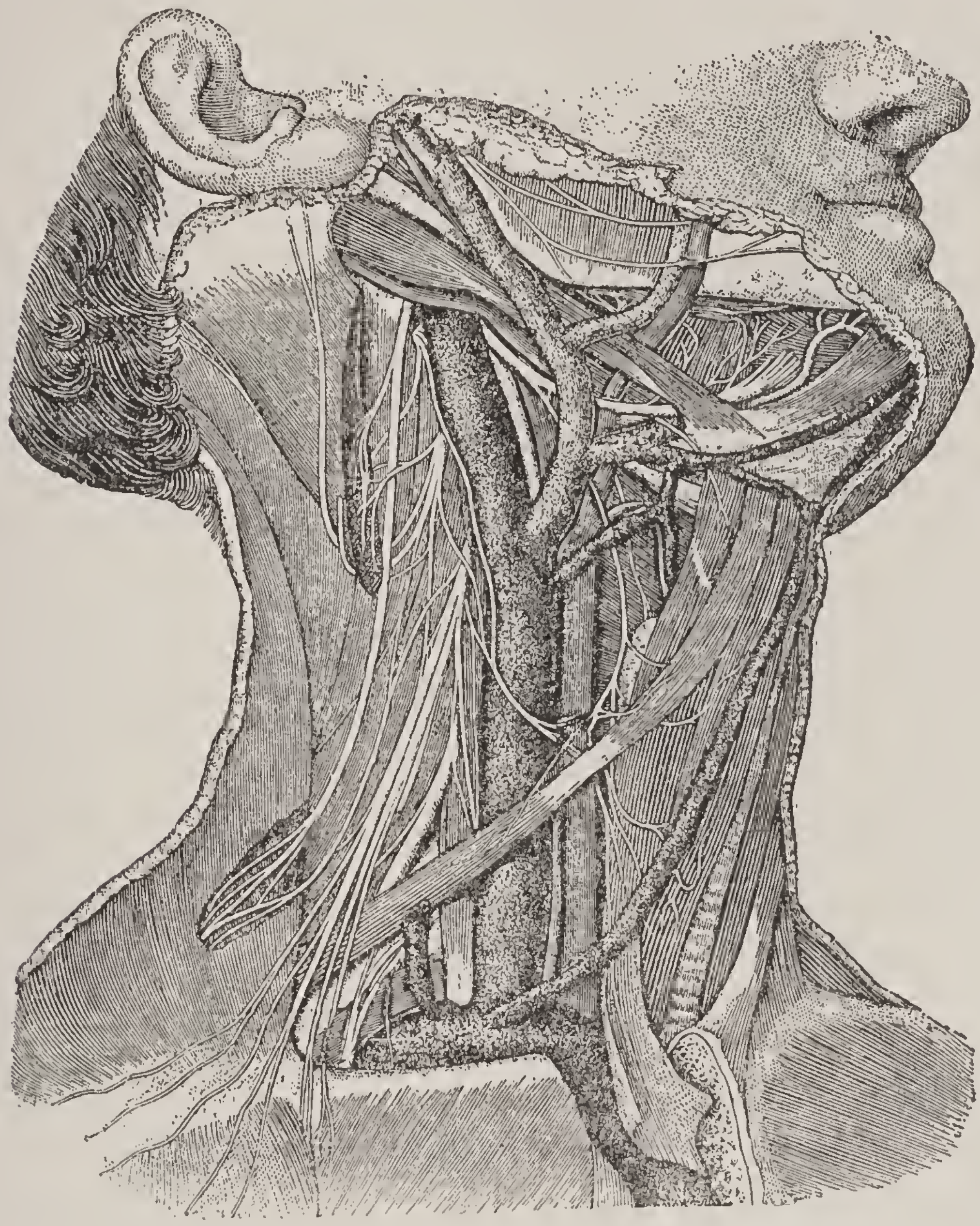
When we reach the spinal cord and the brain, and the lumps or masses of nerve tissue connected with the brain called ganglia, we find a great many nerve cells connected with the fibrous or stringy material. The material of which the cells is composed is grayish in color and is in some respects the most important part of the nerve substance because, in the brain at any rate, it is said that this portion is concerned with the thinking or intellectual work of the body; while the fibers or nerve strings are white and like the electric wires of telegraph wires, are used for carrying messages or impressions.

All of these nerves which I have mentioned belong to a system which is called the system of the brain and spinal cord (cerebro-spinal). In addition to these there is another system independent, in some respects, of that which has been mentioned, though there are branches which go from one to the other so that the headquarters in the brain has some control over this system which we are now referring to and which is called the sympathetic system. It is composed of a series of lumps or ganglia of nerve tissue in a double row, on either side of the backbone, with connecting branches, and with other branches connecting with the nerves of the brain or spinal cord, and yet other branches going to the great blood vessels and to the various organs or machines within the body. These organs must be properly supplied with the sympathetic nerves in order to do their work well, and hence it is said that the nutrition of the body, good or bad, depends upon the way it is served by the sympathetic nerves.

THE TUBES AND PIPES OF THE BODY.

But there are other appliances in addition to the wires which the mechanics must place in the interior of the house. There must be pipes to carry water to every portion of it, and other pipes to carry away the waste material. These pipes must all be kept in good condition, they must not be allowed to get clogged or stopped up, and the fluids in them must flow freely, otherwise there will be trouble and sometimes this trouble may be of a very serious nature. The human body also has a system of tubes which corresponds to the water pipes and another which corresponds to the waste pipes.

The first of these constitute the blood-vessels of the body and the second the lymphatics. Some of you may know how the water supply of a town or city is provided. You know it comes in pipes, there are first the large or main pipes which bring the water from the reservoir, then come the smaller pipes which are tapped as each house or other building makes its connection, and finally there are the still smaller pipes



Arteries, Veins, and Nerves on the Right Side of the Neck.

which are distributed through the building. In the body there are also three systems of pipes or tubes or vessels which carry the blood to every portion of it and then bring it back to the heart from which it started.

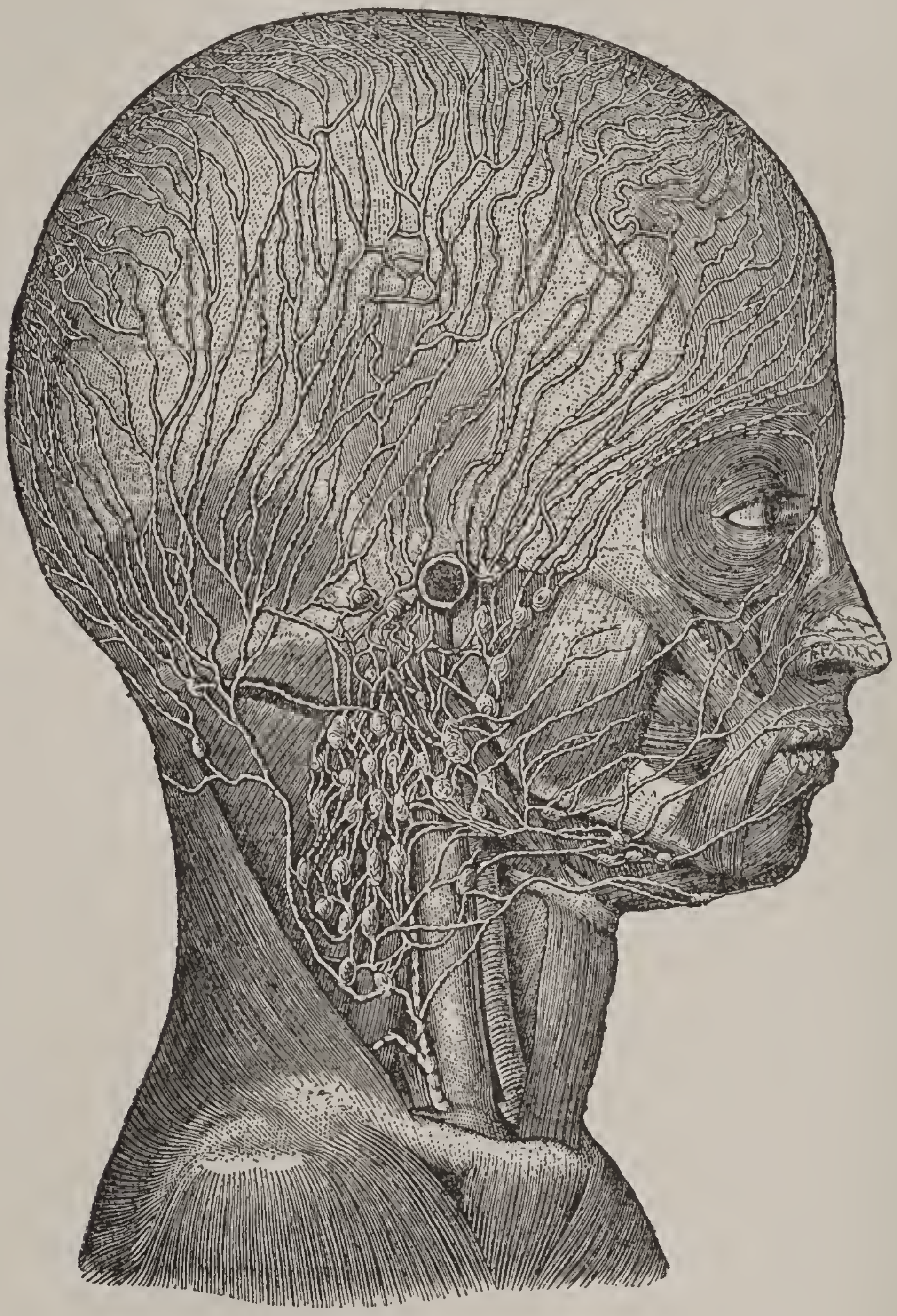
The vessels of the first of these systems are called arteries. The word artery means air carrier because, as it is said, the ancient anatomists examining bodies, either of human beings or of animals, after death found the arteries empty, the blood after death or just before death having accumulated or settled in the veins. The arteries being empty they naturally supposed they were tubes for providing the body with air. This fact also explains the pallor, or in some cases the very dark color of the skin of the dead. It was the great physician Galen, of Pergamus, Asia Minor, 130-200 A.D.; who discovered that the arteries carried blood and not air.

The vessels of the second of these systems are called veins, and bring the blood which has been distributed over the body by the arteries back again to the heart.

The vessels of the third system are called capillaries, from the Latin word which means *hair,* because they are apparently as fine and delicate in their structure as a hair, and they are so small that they cannot be seen with the naked eye. The capillaries are a kind of link connecting the arteries and veins.

The arteries begin at the heart, one large vessel (pulmonary artery) as large around as a man's thumb, going from the right side of the lower part of the heart to the lungs, dividing so as to give a branch to each lung, and then subdividing and distributing branches to every portion of the lungs. The other main or principal artery (aorta), larger even than the one just mentioned, starts from the left side of the lower part of the heart, makes an upward curve and then passes down by the side of the backbone. Large vessels sprout from it like boughs from the trunk of a tree and carry the blood to all the upper parts of the body. When this principal artery reaches the end of the backbone it divides into two parts, and these subdivide again and send branches to every portion of the legs. As the arteries subdivide they get smaller and smaller, and finally, in most cases, connect with the network of little vessels which I have told you were called capillaries. Then the capillaries empty the blood which they have received into very minute veins. As the veins approach the heart they get larger and larger and finally end in two great tubes, one bringing back the blood from the lower portion and the other from the upper portion of the body. These two great veins (vena cava inferior and vena cava superior) empty their contents into the right side of the upper portion of the heart. The arteries are very strong and tough, like India rubber, and are not very easily injured; the veins are less strong and many of them are quite near the surface and can easily be injured. Observe the dark blue lines on the back of your hand; these are veins and it would take but a slight scratch to open them. The capillaries are, as I have said, the finest and most delicate of all and any slight injury which draws blood is sure to open some of them.

There is another system of vessels, most of them very small and fine, which correspond to the waste pipes in the water system of a building. They are called lymphatics, from a Latin word which means a *watery* fluid, and the fluid which they carry is called lymph. One portion of this system of vessels is in the skin. It is arranged in a kind of network and at short intervals some of the tubes become swollen into little pockets or reservoirs. These vessels gather up the broken-down and worn-out cells in the skin, which have become dissolved or melted, and carry them to another set of vessels belonging to the same system but lying deeper within the body, and connected with all the organs and machinery of the body. This internal set of vessels also collects from the intestines, through the mouths of thousands of little vessels (villi) which line the inside of the small intestine, the fluid food, especially that which is of a fatty nature, which passes by them in a current, like the current of a brook, and which has been eaten, digested, and liquified, and is now absorbed as a sponge absorbs water. This fluid food is called chyle and looks



Lymphatics and Lymphatic Glands of Head and Neck.

somewhat like milk, hence these little structures which absorb it are called lacteals, from the Latin word which means milk. Do not forget, however, that these lacteals are a part of the system of lymphatics.

This absorbed fluid joins the main stream of the lymph which is carried in vessels which gradually get larger and larger, and is finally emptied, through two large vessels, one on either side of the neck, into two large veins (sub-clavian) which are under the collar bones. The blood current in these veins takes care of it from this point and we may learn by and by what happens to it afterward.

THE RECEPTACLES FOR VARIOUS ARTICLES.

When the architect is planning the building which we are imagining it would not do for him to forget or neglect to provide places for the storage of various useful materials and substances which may be required in the building from time to time. These are closets or storerooms or even laboratories in which various things can be made which the occupants of the building will require.

The human body has similar contrivances; reservoirs like the bladder and rectum for the temporary reception of waste material, storage receptacles like the gall bladder for the preservation of the surplus product of bile manufactured by the liver until it may be required for the uses of the body, filtering apparatus like the kidneys for separating waste materials from the blood current, and, laboratories like the various glands of the body for preparing the different juices which are essential to its work.

What is a gland? An organ or machine, small or large, in any portion of the body, so constructed that it will take out from the blood which flows through it those materials which must be removed from the body, or which must be so changed and reconstructed that they can be used within the body for its various requirements. The kidneys are an example of the first of these varieties for they take from the blood the substances which constitute the urine and start them on their way out of the body. There are many examples of the second, the liver, the pancreas, the various glands in the stomach and intestines, the salivary glands of the mouth, the mammary glands or breasts, the thousands of lymphatic glands, and many others in various parts of the body.

What does a gland look like? Some of you may have seen a child with running sores in the neck and the doctor says the child has scrofula which is usually another name for tuberculosis. The doctor sometimes operates upon these sores and removes the diseased glands which are the cause of the sores. If he should show them to you, you would see that they are about the size and shape of a bean, and after they have been removed the sores usually get well.

CAVITIES OR HOLLOW PLACES WITHIN THE BODY.

Let us now consider the cavities or hollow places which are within the body which we have been building up. These cavities will correspond to the rooms in the steel-frame building, though of course there are not so many of them. The rooms in the building must have a covering to the beams and posts just as there was a covering for the outside, and so the mechanics attach laths to the sides and ceiling and over the laths they apply several coats of mortar, while boards are nailed down for a floor. In a somewhat similar manner the cavities or rooms of the body must be finished before they can be made ready for the purpose for which they are intended.

The first cavity or room which we will consider is the one which I have spoken of as the second story, or in other words, as the pelvis or basin, for it resembles a hand basin as nearly as anything that I know of. Very important organs are to be placed in this cavity and as I have told you that nature never leaves any organ unprotected, so in this instance the organs are not placed upon the bare bones as you would place a trunk on the floor of a storeroom, but on the contrary the walls are padded with muscles or flesh, wherever they are needed, while over them and covering the entire surface of the cavity is a smooth elastic membrane (peritonæum) which is also to be extended over the organs which are to occupy the cavity as a covering and protection.

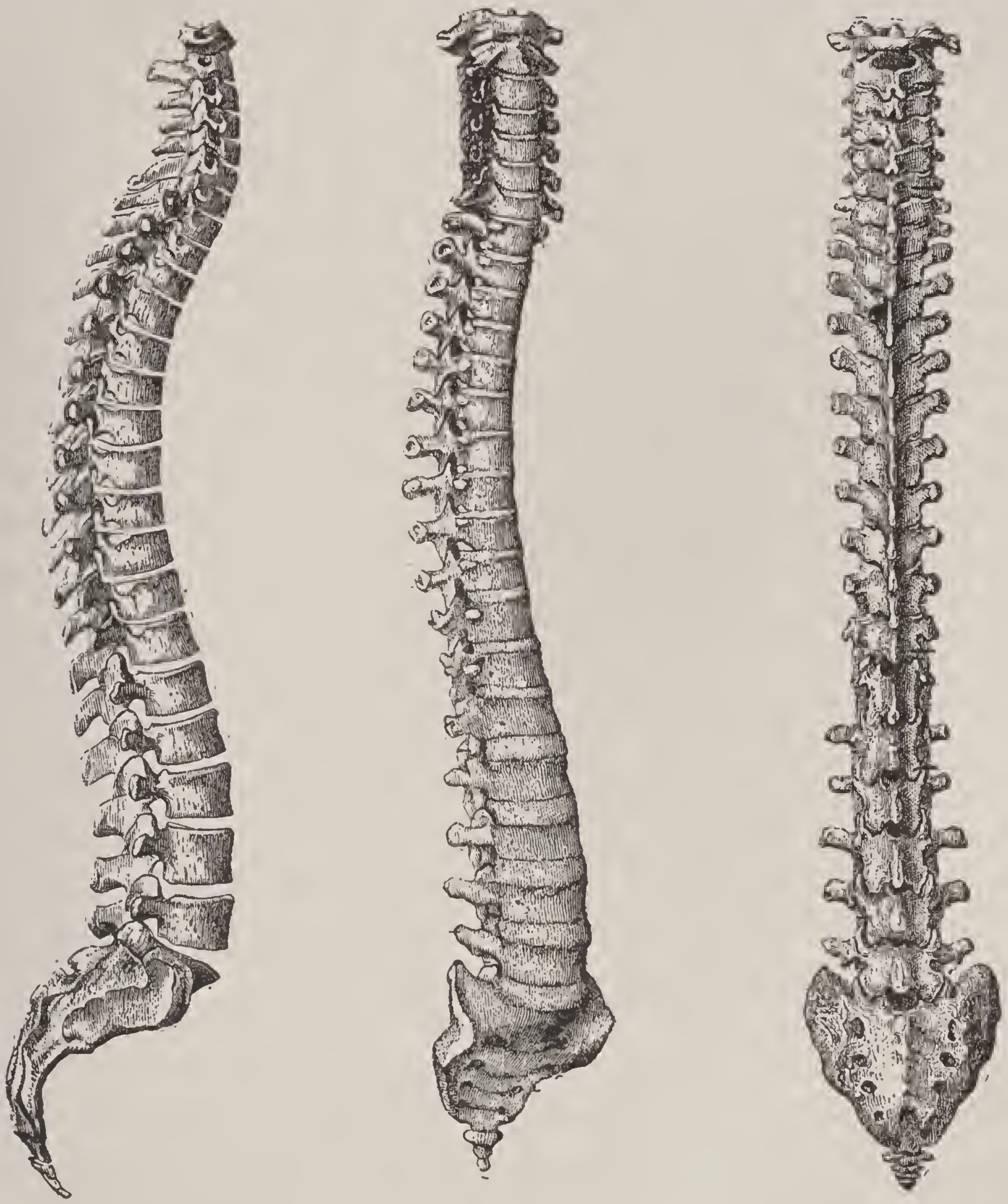
In the next cavity or the third story, which looks so much like a cage, we have what is often called the trunk of the human body, and how much finishing has to be done in order to change the appearance from the cage to the form with which you and I are familiar. A large space in front has to be covered in with muscles and other tissues, while the openings on the sides and back are filled in and padded so that everything is tight and strong. But now comes a peculiar arrangement; about two-thirds of the way up from the bottom of this cavity a strong partition of muscle is thrown entirely across which divides it into two cavities or compartments, the lower of which is called the belly or abdomen, and the upper the chest or thorax. This partition is known as the diaphragm and it has very important work to do, as we shall see.

The lower cavity has a covering which is precisely the same in character and structure as the one which is in the cavity (pelvis) below it and it also has the same name (peritonæum). It also is extended or prolonged over all the organs or machines which are in this cavity to give them strength or protection and to assist in holding them in the places where they belong.

The upper cavity also has a covering of the same structure or material as the one in the two cavities below it, and all three are called by the general name of *serous membranes* for the reason that the fluid which is made in their cells, which is a watery slightly sticky fluid, is called *serum,* its object being not only to keep the membranes moist, but to lubricate or grease them, so that when the organs with which they are covered rub against each other or rub the walls of the cavity in which they may be placed they will not bruise or injure one another.

Now I have told you that the serous membrane covering the belly and also the one which covers the pelvis were called by the same name (peritonæum), but the one which covers the chest has a different name. It is called the *pleura* and you will not forget it because when it is diseased with what is called inflammation the name of the disease is pleurisy, which is a common disease of which all of you have heard, and some of you may have had it. The pleura then not only covers the sides of this cavity of the chest but it is prolonged over each lung, and in such a way that each lung is shut off in a compartment by itself, one on the right side and the other on the left of the chest cavity. Between these two compartments is a space which is occupied by the heart and other very important structures.

In the uppermost story or cupola of the human building we have the cavity of the head, or skull, or cranium, whichever you may choose to call it. In this story is also the cavity of the mouth and throat, and others for the nose, eyes, and ears, but we are principally concerned at the present moment about the main or largest cavity which is designed for the different portions of the brain. This cavity, unlike the others, has no padding of muscle. At first thought this seems strange, as the brain is, in some respects, the most important organ in the body, but the compartment or box in which it is located is so compact and so well adapted to hold it that it does not suffer harm from any of the ordinary movements of the body. Only when it receives sudden and violent shock or concussion, as when one jumps or falls from a building and lands on his feet, does the brain get a severe shaking up and perhaps meet with very severe consequences as a result. There is a lining to the cavity of the skull as there is to all the cavities which have been described.



Spinal Column. Side, Front and Back Views.

It consists of thick firm fibrous membrane applied directly to the inner surface of the bones of the skull. Though it has projecting portions they do not become a part of the brain, as the membrane in the other cavities becomes a part of the organs to which it may be attached. On the contrary these portions of this membrane (which is called *dura mater*) serve as a support and a protection for different portions of the brain. Do not forget that the method of implanting the different organs which occupy the cavity of the head or skull differs from that which exists in the other cavities of the body.

One more cavity remains to be mentioned which in one sense is merely a continuation of the cavity which has just been described. It is that which is within the backbone, or as the doctors would say, within the vertebral column. Remembering the comparison with the steel-frame building, perhaps we might regard it as an extension or addition to the third story or trunk of the human body. The backbone is made up of thirty-three bones, twenty-four of which are separate and distinct and can each be taken apart from the others, then come five bones which are in one mass and cannot be taken apart, and then four more which also cannot be taken apart. These bones, with the exceptions mentioned, are all attached together by cartilages and ligaments and except in the lower portion permit the freest motion of the body. In the front part of each of these bones is a large opening. The arrangement of the bones is such that the opening in one comes exactly opposite to the opening in the bones above and below it. Thus the spinal canal, or the cavity in the backbone, is made up. It it not a straight canal but is gracefully curved forming what the artist Hogarth called the line of beauty. In this canal there is no lining and protecting membrane as in all the other cavities which have been described. The outer covering of the spinal cord which occupies this cavity is indeed continuous with the membrane which lines the cavity of the skull, but it is not attached to the bones which make the cavity, as if nature had been of the opinion that the strong and thick bones which everywhere surround the spinal cord furnished it protection which was sufficient.

MACHINES OR ORGANS IN THE DIFFERENT CAVITIES OF THE BODY.

When the mechanics have finished the construction of a building the next question to be asked is—what is the building for? If it is a house, it is for a dwelling or home; if it is a store, it is to receive and dispose of merchandise; if it is a factory or mill, it is to make certain articles or substances which are supposed to be either useful or ornamental. Let us suppose the building is a factory and that it is to make certain very useful articles, in fact articles which are necessary to life and without which life may not continue. In order to make these articles something more than the bare rooms of the factory will be essential, there must be machinery of a particular kind, it must be placed so that its work will be done in the best possible manner producing the best possible articles, and with as little wear upon the machinery as possible, so that the machinery will last a long time, and require the least possible amount of repairs. A factory which was built along such lines would be a model factory, would it not, and its product would be as fine as anything of the kind could be.

Now we can easily and properly consider the human body as such a factory, capable under proper conditions of turning out the best work and with machinery which, if it is good machinery to begin with, and receives proper care and is wisely used, will last a long time, seventy years or more. Let us see what kind of machinery the different rooms in this factory are supplied with, and how and where they are located.

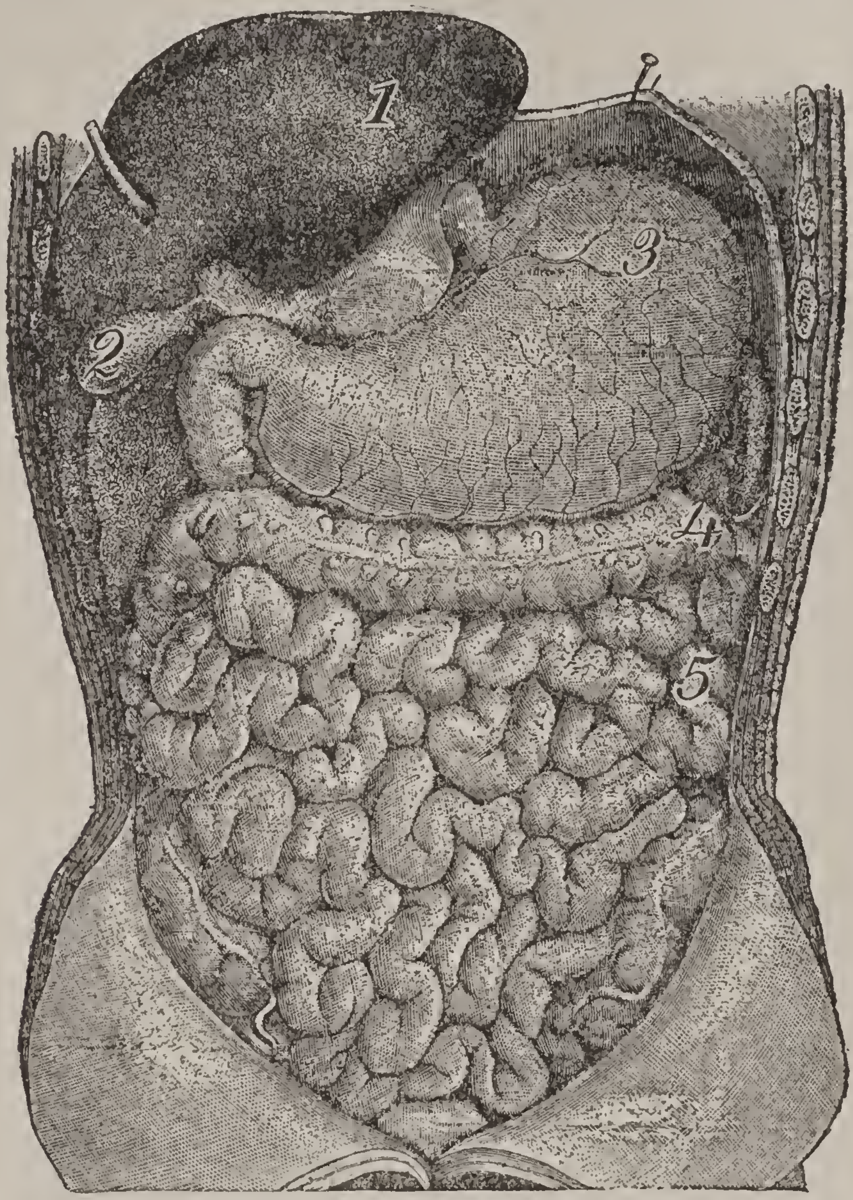
The first room which we will investigate is the one which we have called the second story or pelvis. Remember that the word machinery or machine, in this connection, has the same meaning as the word organ; that is, it is a certain portion of the interior furnishing of the body which has a particular kind of work to do. The portion of the pelvis which contains the organs or machines which we are about to mention is not a large space or cavity; it is shaped like a basin or pot with a round top, holding perhaps two quarts, broader in the female, deeper in the male. Outside of the front portion of this basin are what we called the external generative organs, differing according as the sex of the individual is male or female. In the front portion of the inside of the basin is the bladder or reservoir for holding the urine. Imagine an ordinary rubber toy balloon and you have a very good comparison with the bladder. When there is no air in the balloon it is flat, and its sides come together, but fill it up with air or water and it is like a ball or globe. So it is with the bladder; when empty its sides fall together, but when filled with its contents it is round or oval, holding a quart in some instances. As the contraction of the balloon forces the air or water which it contains out of its mouth or opening, so the contraction of the bladder forces its contents through its outlet or tube (urethra). In the back portion of the pelvis is the end of the intestine or bowel (rectum). As the bladder is the reservoir for the waste material which comes down from the kidneys, so the rectum is the reservoir for that which comes down from the bowel, and it is the contraction of the rectum which empties it in the same manner as the bladder is emptied.

In the female pelvis there are other organs between the bladder and rectum which are called the internal generative organs, the uterus or womb in the middle, the organ in which the wonderful process of development of the unborn child takes place. Attached to the womb on either side is a tube about five inches long called the Fallopian tube, and just below each tube, attached to the womb by a short and slender ligament is the ovary from which come the ova or eggs which are carried through the Fallopian tube to the womb. When the growing child is sufficiently mature, it is pushed or squeezed out of the womb into the canal or tube (vagina) which leads to the world outside the body, in practically the same way that the contents of the bladder and rectum are squeezed out. It is like the pushing of the fledgling bird out of its nest. This cavity, therefore, seems to be intended for storing materials which are to be discharged or squeezed out of the body.

The cavity or story above the pelvis, the third story, is the largest cavity in the body, and remember it is divided into two parts by the muscle called the diaphragm. In these two compartments are located the largest number of the machines or organs of the body, and here the work is performed which relates to the nutrition or feeding of the body, as well as other very important work. Let us first consider the machinery or organs in the lower compartment or abdominal cavity, or belly. The names of these organs are stomach, intestines, spleen, liver, gall-bladder, pancreas, and kidneys.

THE STOMACH.

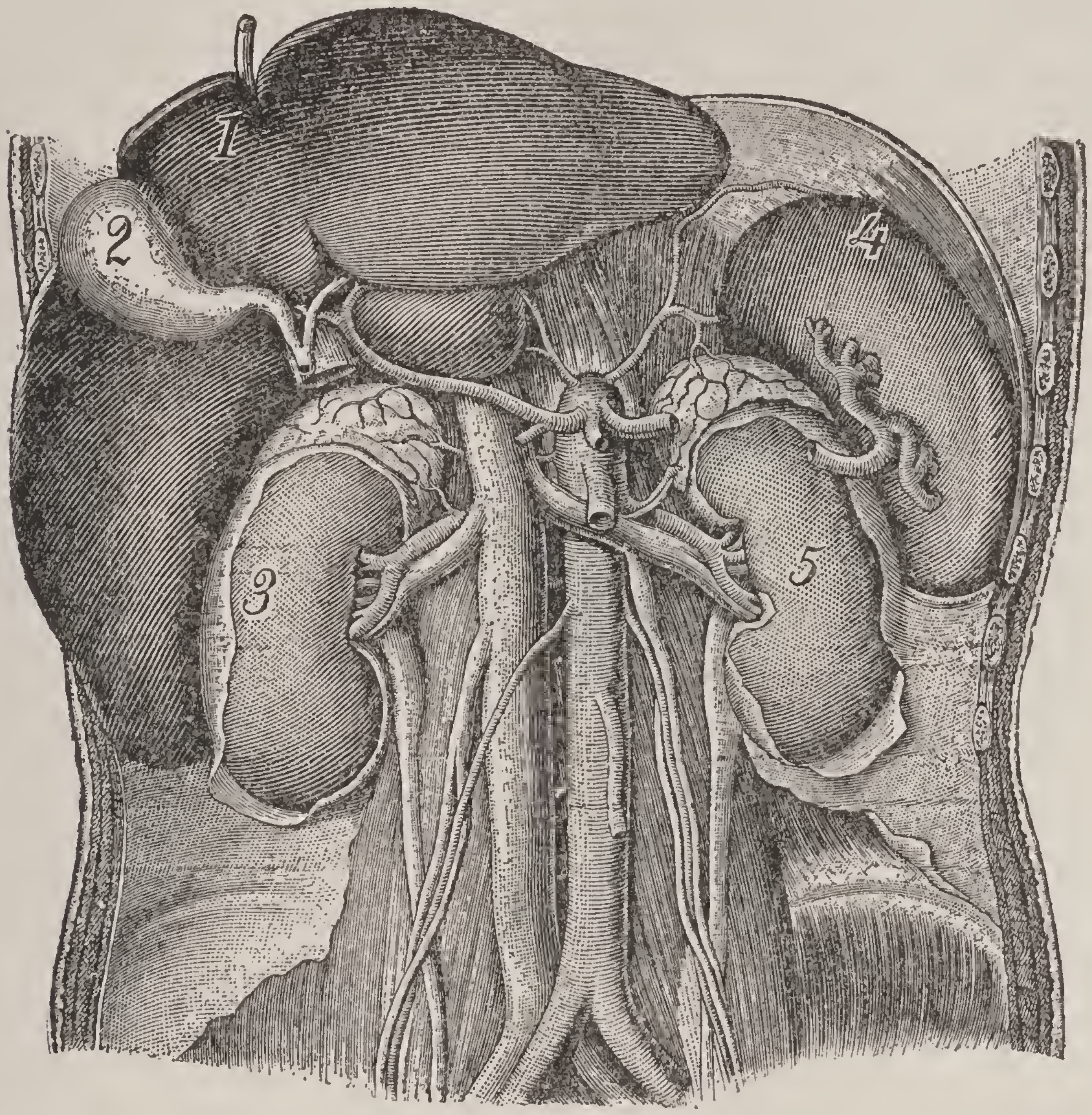
The stomach occupies the upper part of the cavity. It is a hollow bag, like the bladder, measuring about twelve inches from end to end and four inches from top to bottom, concave or hollow above, and convex or bulging below. It lies across the abdominal cavity, from side to side, beginning from an opening a little to the left of an imaginary line which runs from the top to the bottom of the middle of the cavity, bulging in a pouch on the left side of the cavity and gradually narrowing to a round opening half an inch in diameter at its other extremity, on the right side of the cavity, where it meets the beginning of the small intestines. It is made up of an inner or mucous layer which contains thousands of minute glands of two kinds, one of which makes the mucus which mixes with and softens the food in the stomach, while the other makes an acid fluid called gastric juice which digests or dissolves meat, eggs, and other similar substances. Then comes a layer of tissue containing vessels and nerves, then the layer of muscle by which the peculiar motion of the stomach is brought about and finally an outer protective layer (peritonæum). The stomach in a healthy full-grown person holds about three pints.



ABDOMINAL ORGANS
1. Liver turned up.
2. Gall Bladder.
3. Stomach.
4. Large Intestine.
5. Small Intestine.

THE SMALL INTESTINE.

The small intestine begins where the stomach ends. It is a tube about twenty feet in length, passing downward, back and forth, through the middle of the abdominal cavity, to its lower portion, making a variety of curves and loops, attached, by an extension from its outer covering, to the backbone, but very movable in order to accommodate the onward motion of the food substance which it contains. It finally ends in the large intestine in the right lower corner of the abdominal cavity, joining the large intestine at that point. It is constructed in layers similar to those of the stomach. Its mucous membrane, or inner layer, like that of the stomach, also contains a multitude of minute glands which make a fluid which assists in digesting or dissolving such food as potatoes, bread, oil, and other starchy and fatty substances.



ABDOMINAL ORGANS

1. Liver turned up.
2. Gall Bladder.
3. Right Kidney.
4. Spleen.
5. Left Kidney.

THE LARGE INTESTINE.

The large intestine, which is a tube two or three times as large as the small intestine, begins in a pouch several inches below its junction with the small intestine. This pouch has, extending from its lower extremity, a wormlike tube called the *appendix vermiformis,* which everybody has heard about because it is the seat of a common disease which frequently necessitates a surgical operation. The large intestine extends upward along the right side of the abdominal cavity until it reaches the liver, then it bends to the left and crosses the cavity, under the stomach. Then it bends downward, passes down the left side, enters the pelvis and ends in the rectum about which you have already been told. The large intestine is six or seven feet long, is made on the same general plan as the stomach and small intestine, and like them has glands which make a fluid to finish the preparation of the substances which it contains, and which are principally waste matters intended for removal from the body.

THE SPLEEN.

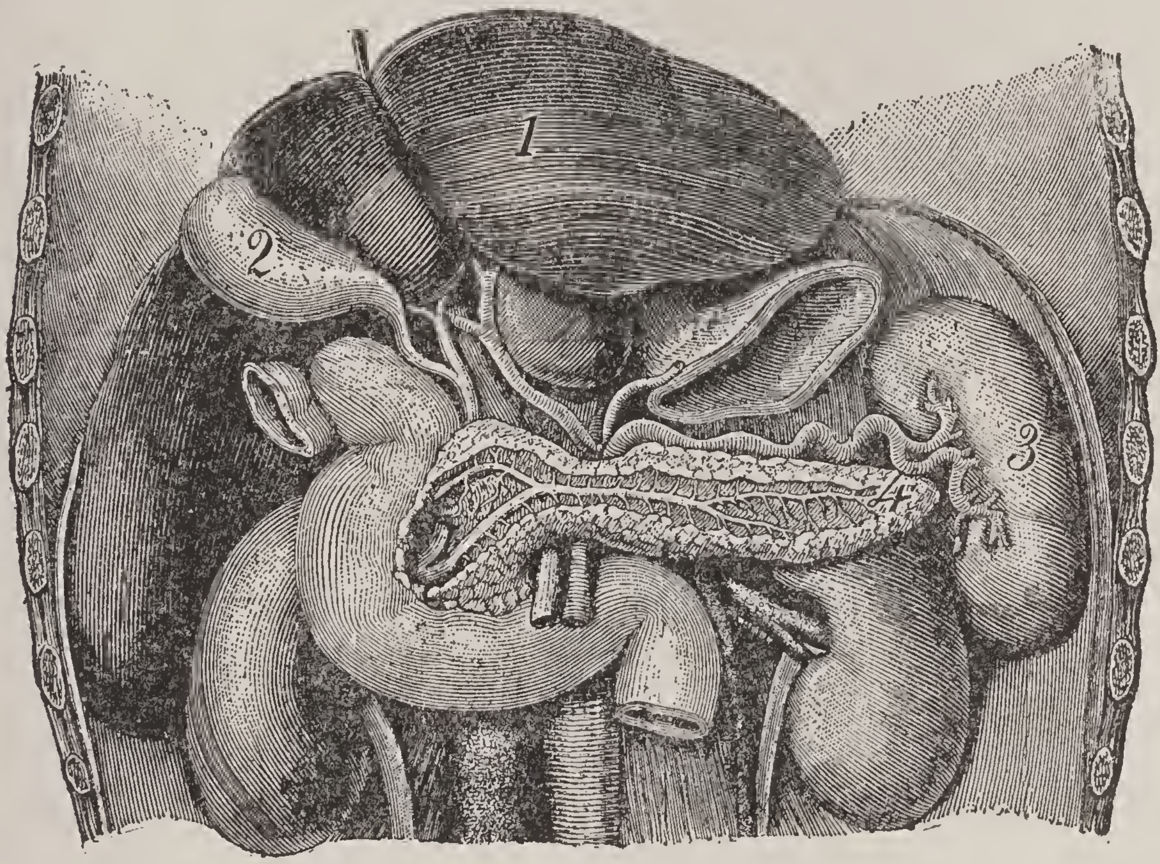
In contact with the large intestine on the left side of the cavity is a solid organ shaped like a bean and called the spleen. It is about five inches long, three or four wide, and one and a half thick. It weighs about half a pound, and in its longest dimension is parallel with the sides of the abdomen.

THE LIVER.

On the right side of the abdominal cavity, in its uppermost part is the liver, which is also a solid organ, and is shaped somewhat like a Derby hat, but without the brim. Its top is convex or bulging and fits nicely under the diaphragm. It is the largest organ in the body and weighs three or four pounds. It measures ten to twelve inches from side to side, when it is in position, and six or seven inches from front to back.

THE GALL-BLADDER.

Just under the liver and attached to it, with its large end foremost, is a small sac or bag called the gall-bladder. It is about four inches long, and one inch wide at its widest part. It holds about two tablespoonfuls and is used as a reservoir for the surplus bile which is made by the liver. It is very often the seat of disease and within it are often formed stones, sometimes small, sometimes large, sometimes in great numbers. In trying to pass out of the gall-bladder by its tube or canal, and get into the intestine, they may cause the most excruciating pain. They are very frequently taken out by the surgeon.



1. Liver. 2. Gall Bladder. 3. Spleen. 4. Pancreas.

THE PANCREAS OR SWEETBREAD.

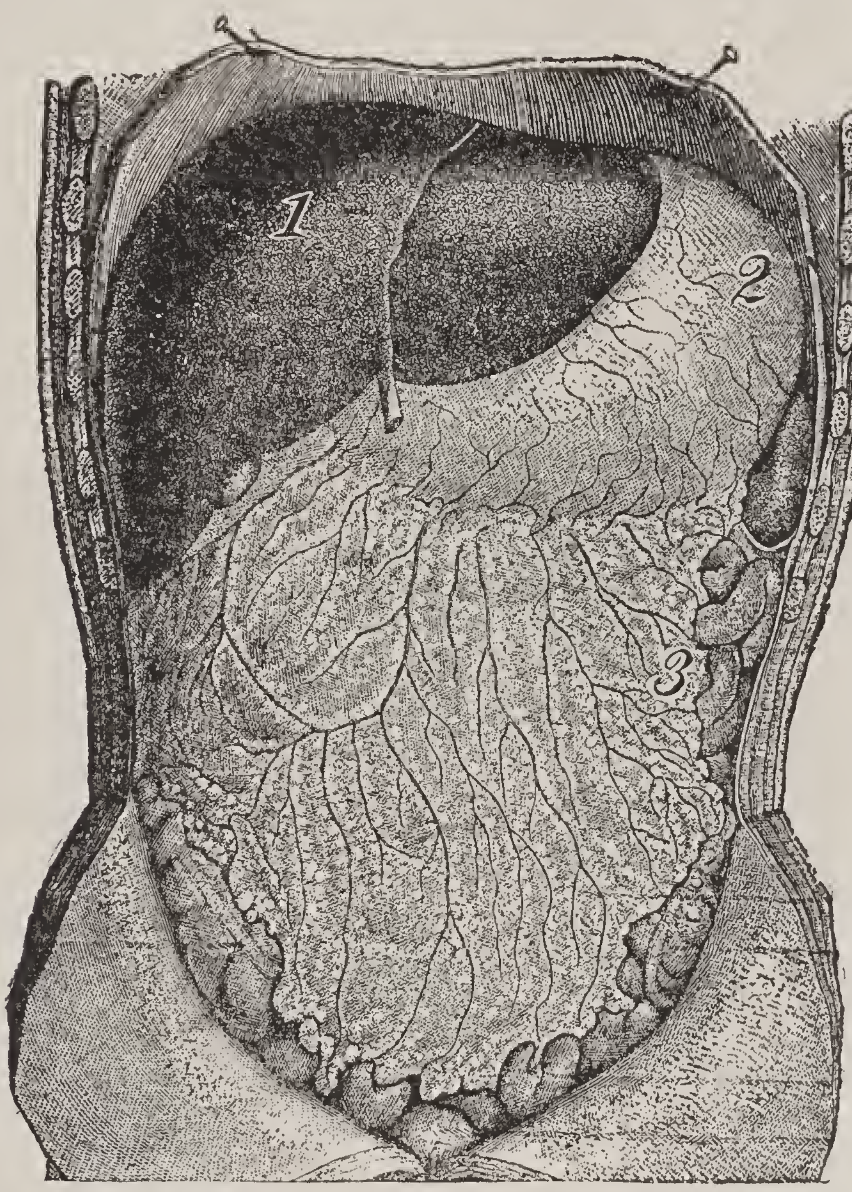
To the left of the liver and behind the lower portion of the stomach lies a small organ, six to eight inches long, parallel with the lower portion of the stomach, which is said by the anatomists to resemble a dog's tongue. It is called the pancreas or sweetbread and weighs about three ounces. Although it is small, it is immensely important for within it is made a fluid called the pancreatic juice which is poured through its tube into the small intestine a very short distance from its junction with the stomach and very near the entrance of the tube which conducts the bile from the liver into the intestine.

THE KIDNEYS.

The kidneys are located on either side of the backbone, midway between the bottom and the top of the abdominal cavity. Like the spleen they resemble a bean in appearance and are about four inches long and two inches wide. They weigh from five to six ounces each and are surrounded by fat which usually prevents them from slipping out of place. Sometimes, however, this protection is insufficient and they become loosened, and slip downward. This may result in discomfort or even in serious illness to the sufferer.

The longest dimension of the kidney is parallel with the backbone. If you recall the shape of a bean you will remember that one side bulges or is convex while the opposite side is hollow or concave. It is this hollow side which lies next to the backbone and from its middle point comes a tube or duct, in each kidney, which passes down by the side of the backbone until it reaches the lower portion of the bladder in the pelvis. These tubes or pipes are called ureters, and they convey the urine which has been screened or filtered from the blood which flows through the kidneys down to the bladder from which it is discharged out of the body; like the water which comes from a spring on the hillside and flows through a brook to a pond or lake.

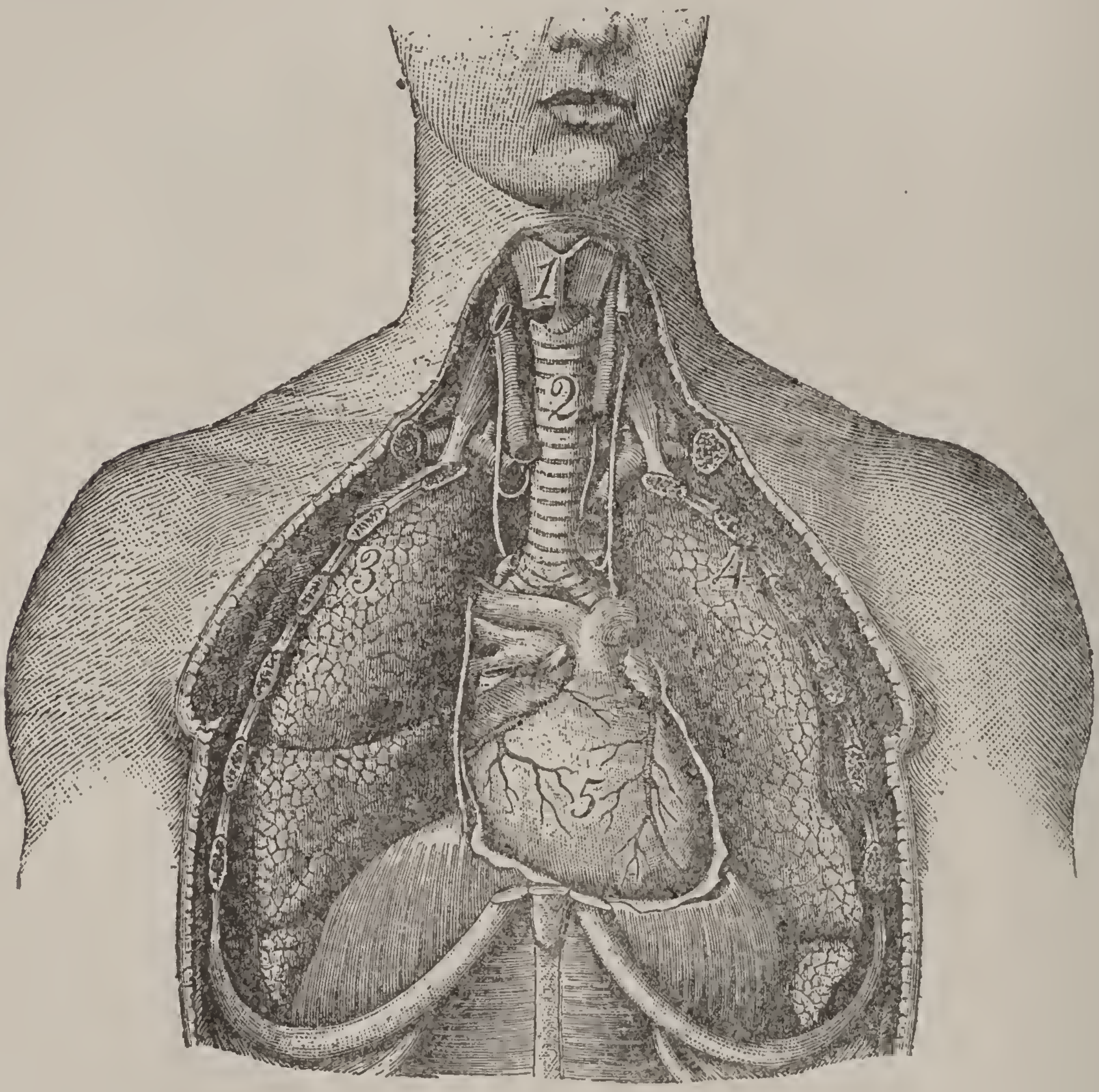
These, then, are the principal organs which are to be found in the abdominal cavity, but we must not omit to add that at the lower border of the stomach is attached an apron or curtain which is composed principally of fat enclosed between two layers of the same kind of membrane (peritonæum) which forms the outer covering of practically all the organs in the abdominal cavity. This apron is called the omentum and varies very much in size and thickness. It covers the intestines in front and is probably intended to protect them from extremes of heat and cold. The abdominal cavity or belly may therefore be considered as the engine room where fuel is received and heat and nutrition developed.



1. Liver. 2. Stomach. 3. Omentum.

You will remember that I told you that the great cavity of the trunk of the human building is divided into two compartments by a thick muscle called the diaphragm. This muscle has a large opening in its back portion through which important structures pass. I have told you what was in the lower compartment let us now see what is in the upper one.

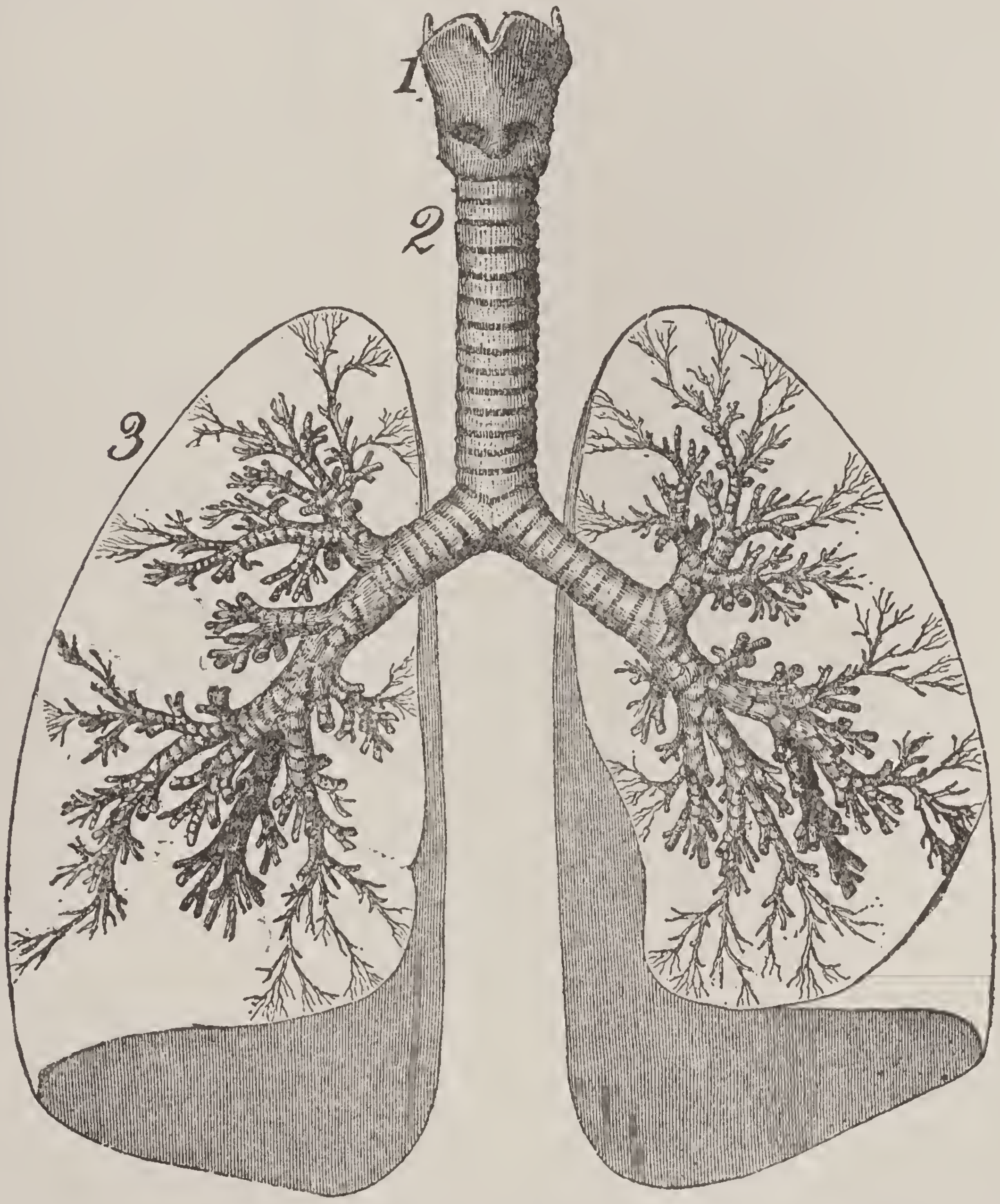
The organs or machines in this compartment are the heart and lungs, but in it are also the long tube called the windpipe (trachea) which conveys air from the mouth and nose to the lungs, the long tube called the gullet (œsophagus) which passes from the throat to the stomach, and the great vessels which spring from the heart and carry blood to the lungs and to all portions of the body from which it is returned again to the heart. Some of these vessels as well as the gullet pass through the opening which I told you was in the back portion of the diaphragm.



1. Larynx. 2. Trachea or Windpipe. 3. Right Lung. 4. Left Lung. 5. Heart.

THE LUNGS AND WINDPIPE.

The windpipe or trachea is a firm, strong tube which begins at the lower portion of the throat and passes downward in front of the gullet, which is the tube which conveys the food to the stomach, for about four and a half inches. At that point it divides into two parts, called the right and left bronchus, one going to the right lung and the other to the left.



1. Larynx. 2. Windpipe. 3. Right Lung, showing Bronchi and Bronchial Tubes.

The lungs, as I have told you, are each in a compartment of this chest cavity by itself. The right lung is divided into three masses or lobes and the left into two. They are composed of soft spongy tissue with blood vessels, large and small, in every portion of them. When the bronchus, which has branched off from the windpipe, enters the lung, it divides and subdivides into smaller and smaller tubes, called bronchial tubes, which go to every portion of the lung. The smallest tubes end in little bulbs called air vesicles and each air vesicle is surrounded by blood vessels. All the blood in the body passes through these blood vessels at very short intervals, in a continuous current.

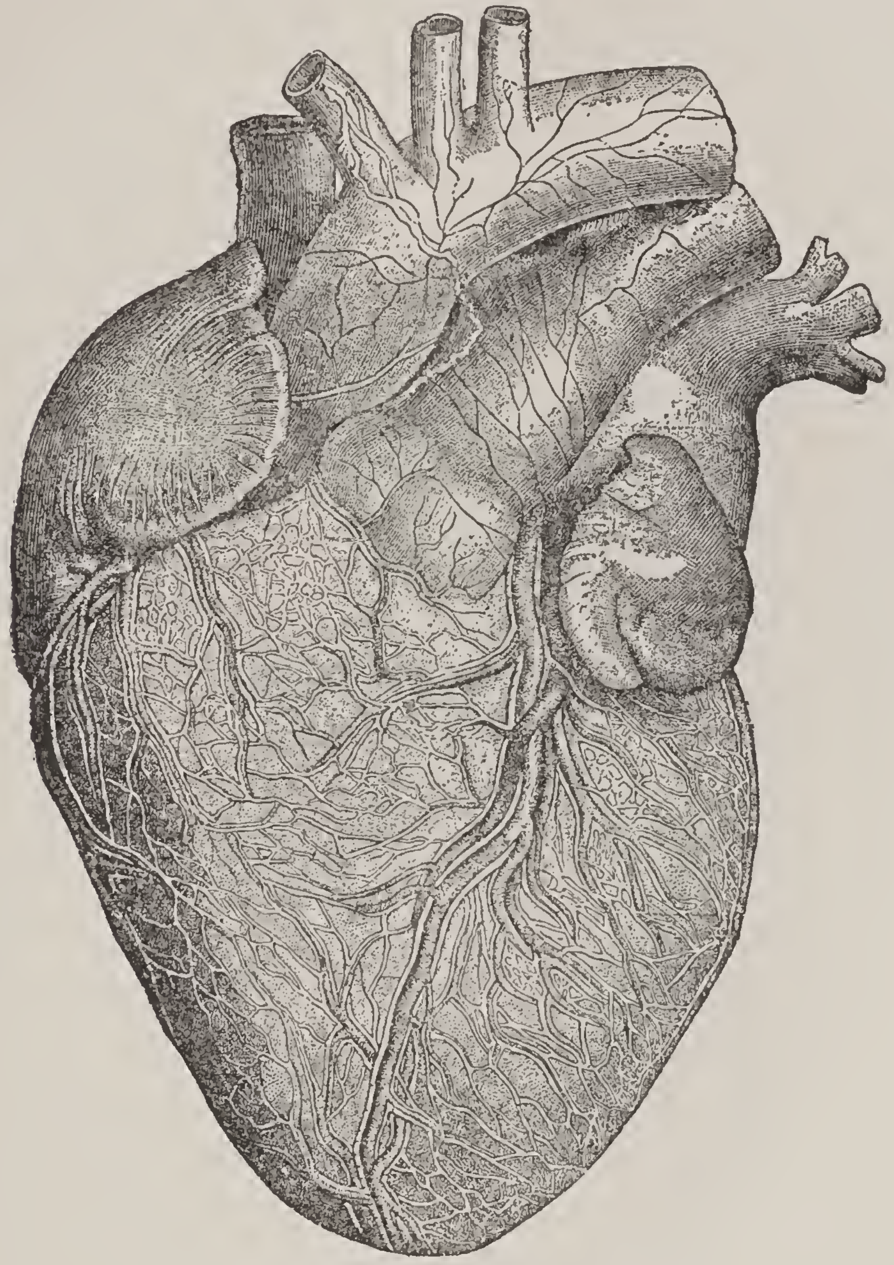
The right lung weighs about twenty-two ounces and the left about twenty, but when they are swollen with the fluid which accumulates in them in the disease which is called pneumonia or lung fever they weigh much more than this. When one draws in the air through the mouth or nose, or, as we say "takes in a breath," the air rushes into these thousands of air vesicles and they swell out like so many toy balloons. Of course the lungs are then much expanded and enlarged and each one nearly fills the cavity in which it is placed. But when the air is breathed out all these vesicles or balloons collapse, the lungs get very much smaller, and there is an empty space between them and the wall of the cavity in which each is placed.

THE GULLET.

Behind the windpipe is the long tube called the gullet or œsophagus. It begins at the lower part of the throat and passes straight downward nine inches, in front of the backbone, through the opening in the back part of the diaphragm, and joins the stomach at its left upper extremity. It is of course a very important tube because it forms the only way which the food which is taken into the mouth can get into the stomach and be digested.

THE HEART AND MAIN ARTERIES AND VEINS.

Between the lungs but in a separate compartment lies the heart with its great vessels. It is shaped like a cone with the broad end upward and the apex, or point, downward. It is enclosed within a firm strong bag (pericardium) which is composed of two layers, the inner one folding over and being completely attached to the heart, as the pleura covers the lung. There is a space between the heart and the bag which holds it, just as there is a space between the lung and its pleura.


Heart and Principal Blood Vessels.

The heart is divided into four chambers, two small ones above (auricles) and two larger ones below (ventricles). A partition from top to bottom divides it into two unequal parts, and another from side to side, one-third of the distance from the top, divides it into upper and lower chambers. It is five inches long from base to apex, three inches and a half in its widest part, and two and a half inches thick. It weighs from eight to twelve ounces in health but when diseased it may be much lighter or much heavier. It is the seat of many diseases. Into its upper chamber on the right side pours all the blood in the body by two great veins. From the lower chamber on the right side the blood all flows out by a great artery (pulmonary artery) which bears it to the lungs. Into the upper chamber on the left side the blood pours back through four large veins, after it has been purified in the lungs, while from the lower chamber on the left side, which has received the blood from the chamber immediately above it, the current pours in a great stream through the main artery or pipe called the aorta, and thus begins its course around the body again. The entrance to the artery in each of the lower chambers is guarded by a valve which opens as the heart contracts, to let the blood out, and then immediately closes to prevent it from flowing back. In the partition between each upper and lower cavity there is also a valve which opens and shuts to admit the blood from each upper chamber and prevent it from flowing back.

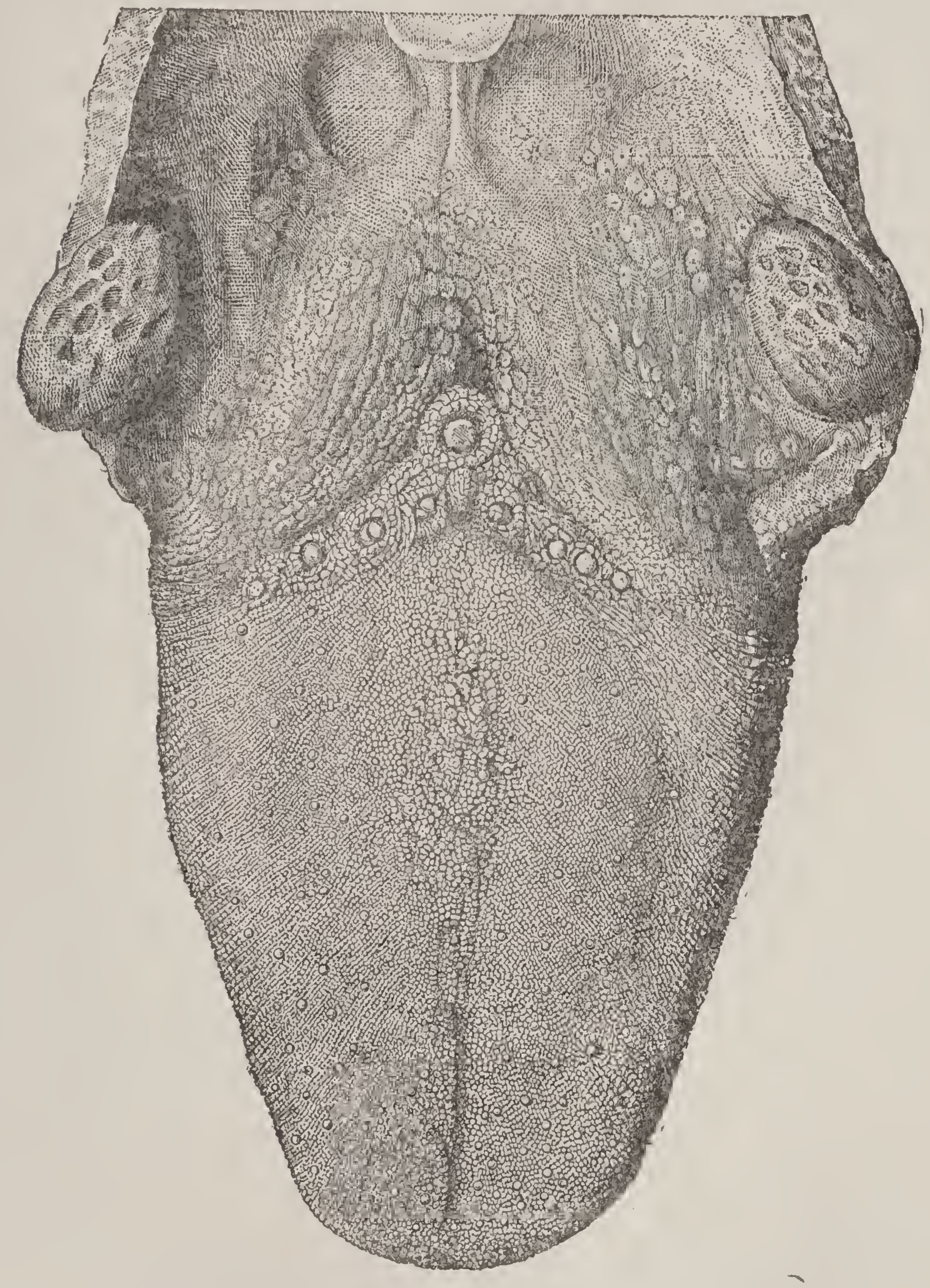
The heart is composed principally of muscle, and contracts and relaxes, shortens and lengthens like India rubber, and like all muscular tissue its machinery is of a very delicate and a very perfect character. It is constantly working night and day, never stopping for a vacation, never closed for repairs. Is there any other machine that you know of that will work seventy, eighty, ninety years without stopping once? Is it strange that it gets out of order when it is not properly managed?

The compartment of the cavity which we have just described contains, as you have seen, the pumping machinery which supplies indispensable fluids to the entire structure, and it also contains the machinery by which it is thoroughly ventilated.

We now come to the fourth story, or cupola, which contains the most wonderful machinery of all.

THE MOUTH AND ITS CONTENTS.

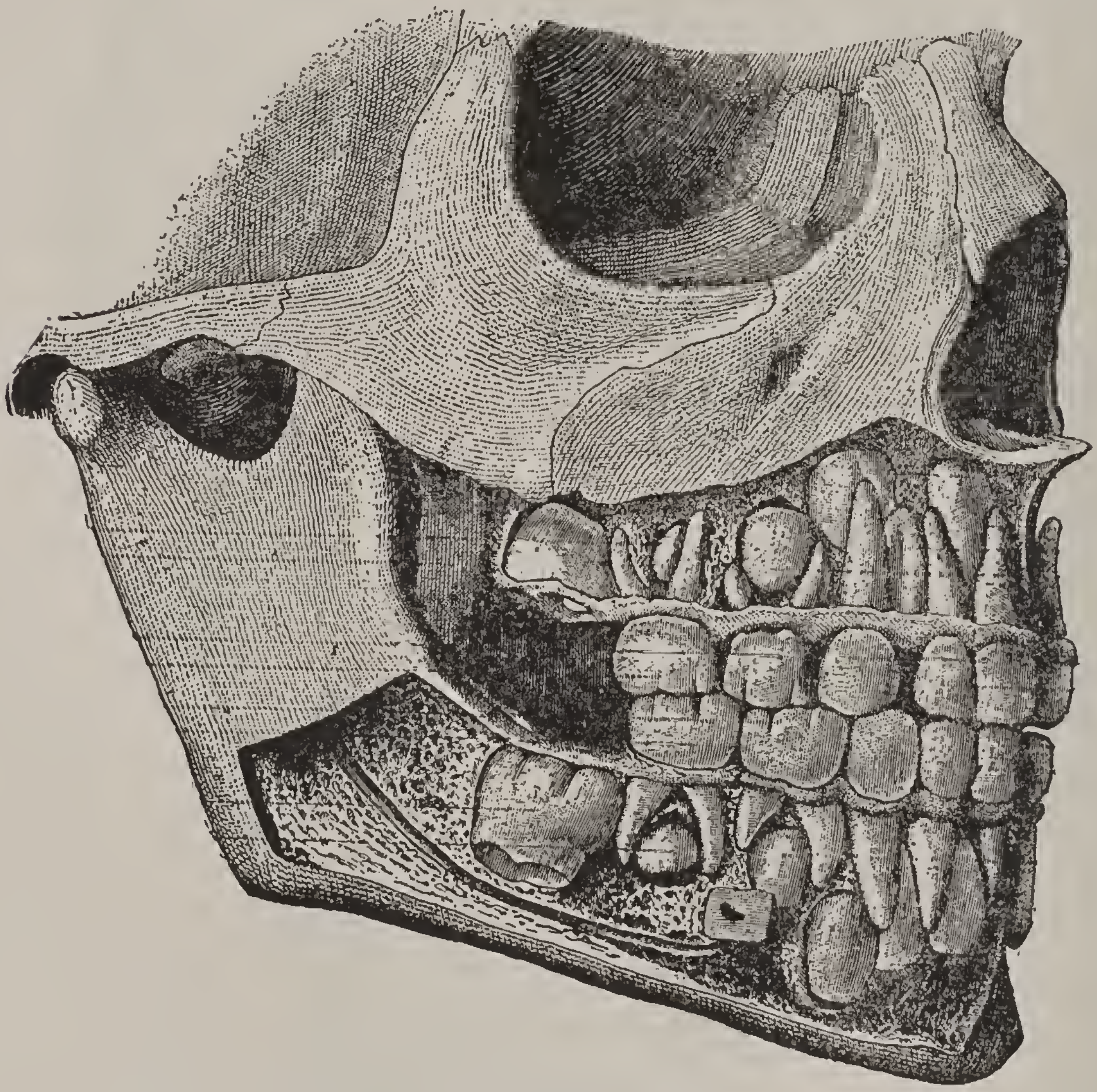
What an interesting piece of machinery we have in this portion of the building; an oval cavity with a double row of teeth of different sizes, and made for different purposes; a lower jaw that works up and down and makes you think of a stone crusher; a tongue



Upper Surface of Tongue and its Glands, also Tonsils.

which moves in almost every direction, conveys your food, gives you sensations of taste, and helps you in talking; a bony palate above for protection from injury against hard substances; gums which form firm sockets for the teeth; lips which assist you in eating and furnish protection at the entrance to the mouth; contract the muscles of which the lips are composed, they close, and nothing can enter.

Important also are the glands which furnish the saliva to the mouth, keeping it moist and helping to digest the food. There are five of these glands; one is under the tongue, one is under each ear, and these are the largest of all, and one is under the lower portion of the middle of each lower jaw. Back of the mouth is the throat or pharynx, an extension of the cavity of the mouth, with the tonsils, like sentries, on



Teeth, showing the arrangement of the first and second sets.

either side and the little uvula hanging like a curtain in front. Where the throat ends the gullet begins and this has already been sufficiently described.

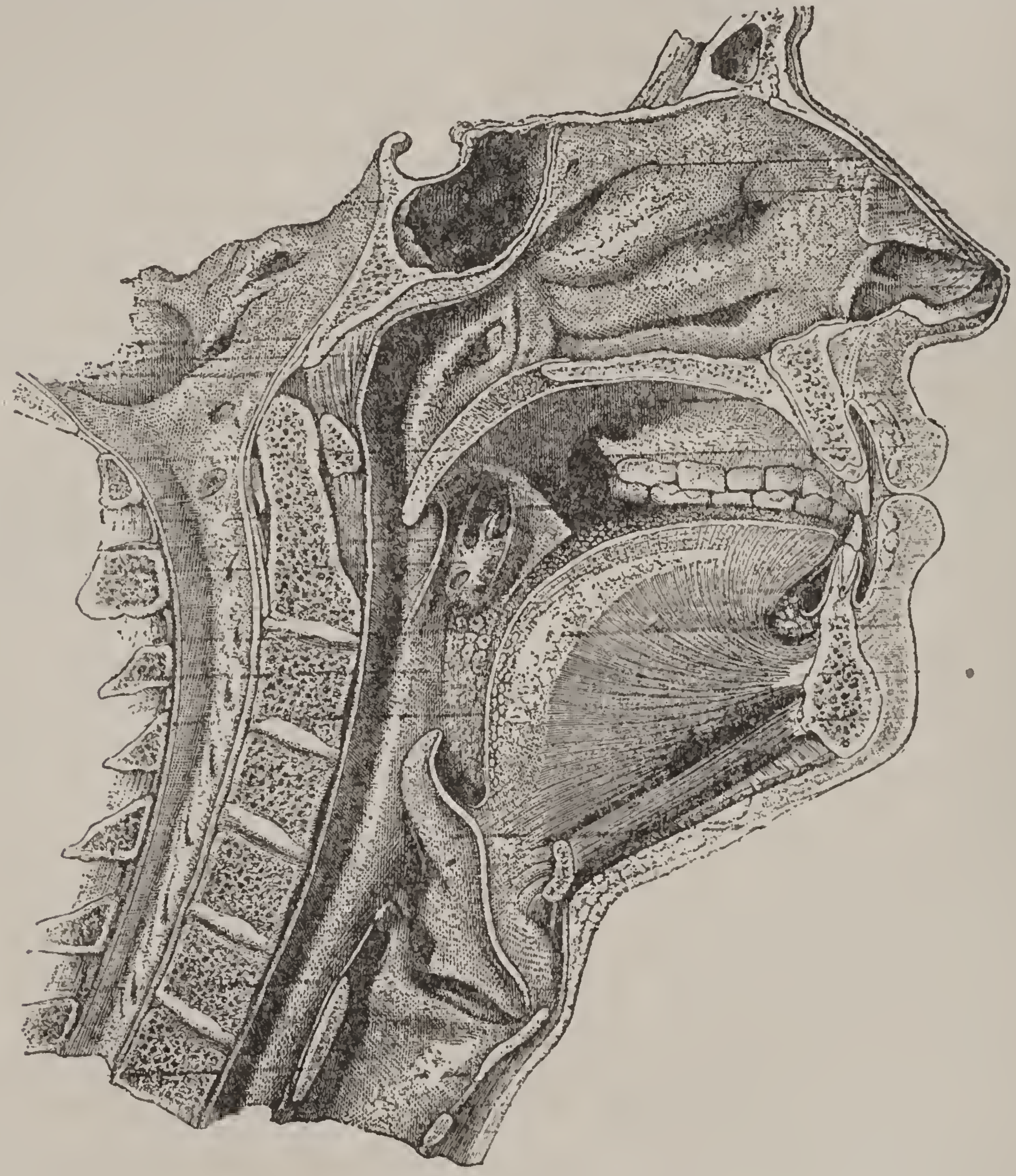
Let me say a word more to you about the teeth. They are soft in the beginning, made up principally of cells like all the rest of the body. Gradually they become hardened by the addition of different combinations of lime, so that their structure is very similar to that of bone. The enamel of which they are principally composed is harder than bone and this is what might be expected when we consider the work which they have to do. There are two sets of teeth, the first one is for use during childhood, and the second for use during the remainder of life, or until they are worn out. There are twenty in the first set and thirty-two in the second.

It is interesting to note the manner in which nature provides for their development in the jaws. What a misfortune it is when the teeth are imperfect either from ill health or from want of proper care. You cannot be too particular in keeping them clean and having them repaired as soon as they begin to decay.

THE NOSE AND ITS CONTENTS.

Perhaps you have never thought of the nose as a complicated apparatus, nor of its importance to every individual. Imagine a person without a nose, and there are many who have lost it by disease or injury, and you will realize not only how hideous is one's face without it, but also how much discomfort it causes from inability to breathe properly, for the nose is not only the organ of smell, but it is the channel through which the air is intended to pass on its way to the lungs. Those who breathe through the mouth do not breathe properly.

The bones of the outer part of the nose are small, meet in the center, and are covered by skin and muscle which extend much below them as you can tell by passing your fingers from below upward, over the soft parts until they reach the harder structure of the bone. Within the nose there is a lining of mucous membrane which is very often the seat of disease especially in the young, then two pieces of cartilage or gristle on either side and another in the middle. The nasal openings or nostrils not only extend back to the face but into the skull, until they finally communicate with the throat. No less than eight different bones are connected with the nasal cavity, and there are communicating channels with the eyes, the ears, and the throat.


Cavities of Mouth and Nose.

THE EARS.

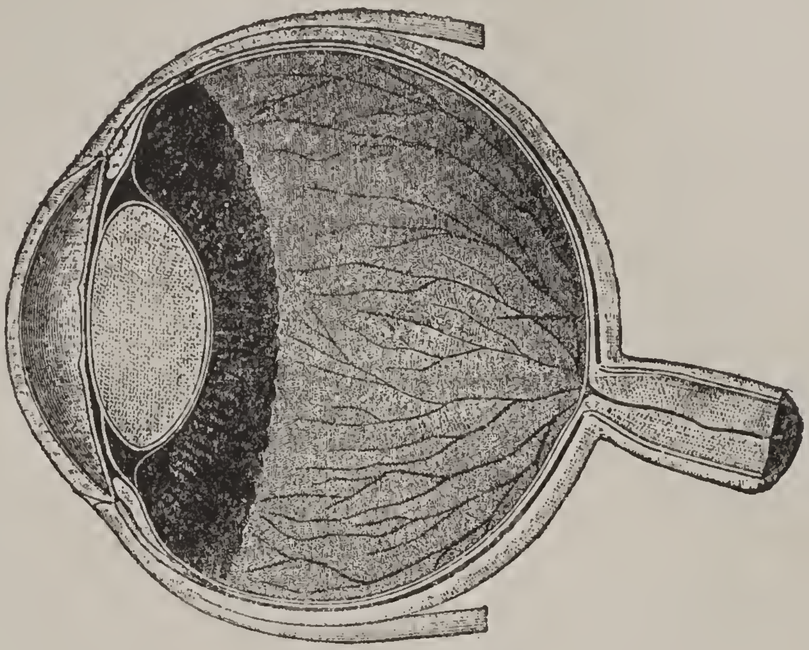
The ears are the organs of hearing; each one consists of three parts. The outer portion has sometimes been compared to a shell in its appearance and it does have some resemblance to an oyster shell. Near its lower portion is a small opening entering into the skull, and leading to a kind of curtain which completely closes the canal in which it is situated. This curtain is called the drum or the drum membrane. As the waves of sound reach it, it vibrates back and forth like the diaphragm of a telephone receiver.

Beyond the drum membrane is the middle ear, which is a small compartment about half an inch long, in which is the opening of a tube which leads to the throat and other openings which lead to the bone called the mastoid bone. This is an important thing to remember because this bone is frequently the seat of a severe disease, especially in children, and a severe surgical operation may be necessary to save the life of one who suffers with it. In this compartment there is also a chain of three minute bones which are connected with the drum membrane and vibrate with its vibrations.

Beyond the middle ear is the internal ear, or labyrinth, a very curious irregular bony structure within which are the ends of the nerve which carries the impressions of sound to the brain.

THE EYES.

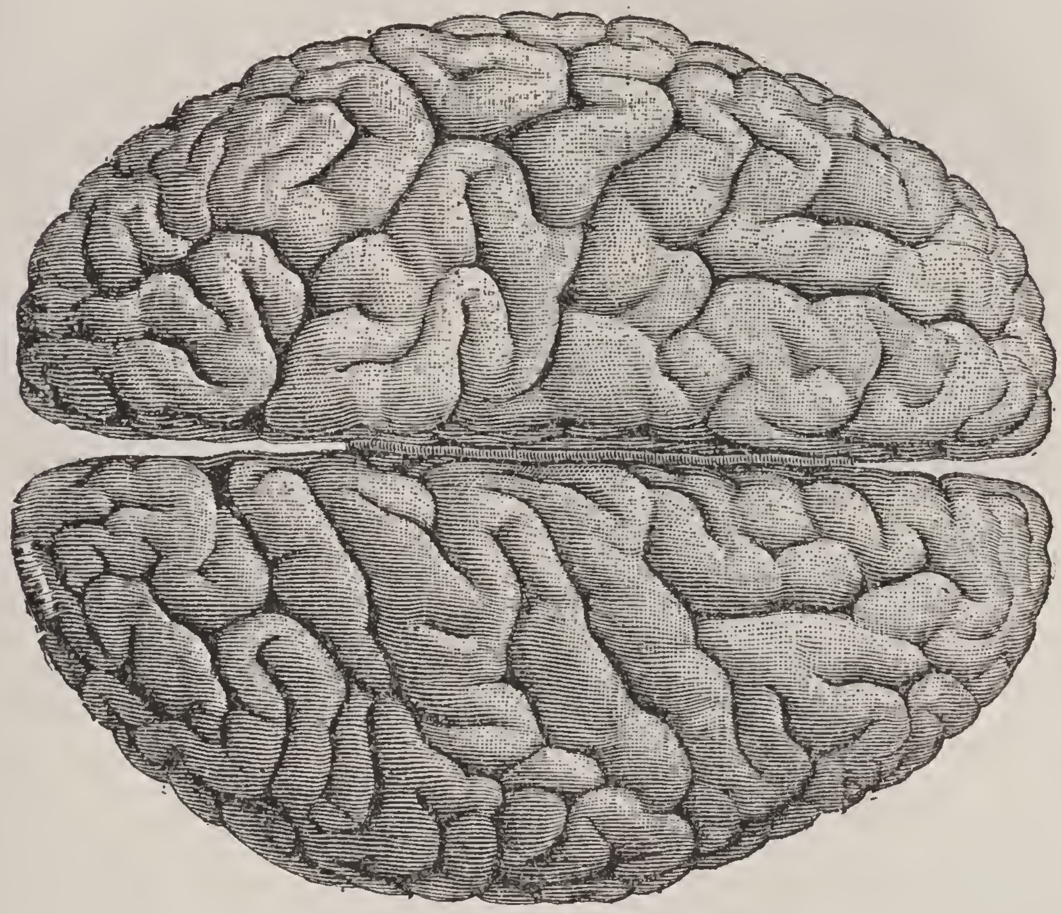
The eyes are placed within two cavities of the skull which are called the orbital cavities. They are protected by bony walls surrounded by fat and connected with muscles which permit them to move in any desired direction. Each eye is shaped like a globe or sphere, with a small portion of another sphere, inserted in its front portion, perfectly transparent, looking like a watch glass, and called the cornea. Behind the cornea is a double compartment containing a transparent fluid, while separating its two portions is the fringe or curtain called the iris with an opening in the center called the pupil. The iris is black, or of blue, or grey, according to what we call the color of the eyes. Behind this compartment is the lens which receives the rays of light from the front and passes them through and diffuses them. The lens is very often diseased in old age and produces blindness from the condition which is known as cataract. Behind the lens and filling the larger portion of the cavity of the globe is a transparent jelly-like substance, and in the back portion of the compartment which contains this substance is the opening through which the nerve of sight called the optic nerve, passes on its way to the brain. As this nerve enters the globe of the eye (coming from the brain) it expands into a delicate membrane called the retina which lines the entire compartment which is filled with the jelly above mentioned and which is called the vitreous or glassy body. The images of objects in the outside world having passed through the lens are diffused over the retina and then transmitted by the optic nerve to the brain.


Globe of the Eye.

THE BRAIN.

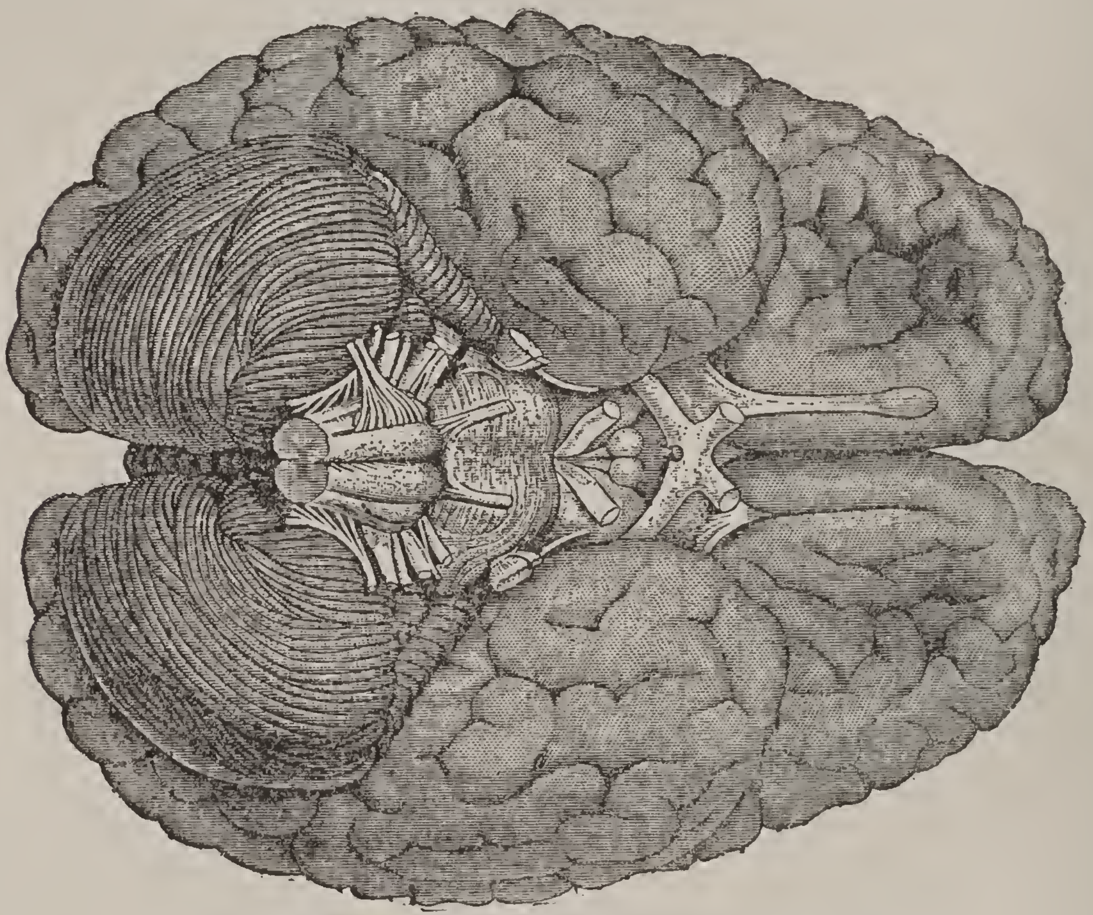
The brain is the center or headquarters of the nervous system, as the heart is the center of the system of the vessels of the body. It occupies the principal cavity of the skull and is covered by three membranes. The outer one (dura mater) is not really a part of the brain and is not attached to it but to the inner surface of the skull. Then comes a thin delicate membrane like a spider's web (arachnoid), and under that another thin membrane (pia mater) which contains the blood vessels which supply the brain with this indispensable fluid.

The brain is the organ by means of which we think, and will, and organize the daily and hourly work of life. The larger it is the more efficient and capable the person who uses it, as a rule, and the greater his power over the conditions with which his life brings him in contact. In the upper part of the skull cavity are two large masses of brain substance, side by side, called the cerebral hemispheres, their appearance somewhat resembling half a globe or hemisphere. Beneath and behind their back portion is a smaller mass called the cerebellum or little brain, and in front of the cerebellum is a small and very sensitive mass of nerve tissue



Upper Aspect of the Brain, showing the Hemispheres.

called the *medulla oblongata.* Under the hemisphere, in front of the medulla are a number of masses of nerve tissue called the cerebral ganglia, and from different portions of the brain arise twelve pairs of nerves, called the cranial nerves, which are distributed to different organs of the head, chest, and abdomen. All these organs or masses are made up of nerve cells and very fine fibres of nerve tissue, and bands composed of these fibres connect the hemispheres with the cerebellum and the *medulla oblongata* passing, on the way, through a small body called the *pons,* or bridge, from which they are continued into the spinal cord.



Lower Aspect of the Brain, showing its Various Parts.

THE SPINAL CORD.

You will remember that I told you in the statements relating to the nerves that the spinal cord was a kind of continuation or extension or tail of the brain in so far as the substance of which it is composed is concerned. It occupies the spinal canal or the cavity of the backbone, is cylindrical in shape, sixteen or seventeen inches long, and is separated from the bony walls of the cavity by a mesh work of veins embedded in a quantity of fat. It is covered by three membranes which are continuous with those which cover the brain.

Like the brain it is divided into two halves which are connected all the way down in the center of the cord, and from either half, from the top to the bottom of the cord, arise thirty-one nerves, each of which has two roots, one in front and one behind. All the nerves, whether proceeding from the brain or the spinal cord, divide and subdivide until they have reached every portion of the body. The root of each spinal nerve which is behind or posterior is called the sensory root because it brings impressions or sensations from the surface of the body, by way of the proper branches, and transmits them along the fibres of the spinal cord to the brain. From the brain they are sent down the cord again to the front or anterior root, which is called the motor root, and from this root the impressions travel to the muscles to which the branches of this nerve may be distributed, cause them to contract or shorten and so produce motion of the part which is controlled by these muscles.

CHAPTER IX.

Substances Which are Made In or By the Body.

THE IMPORTANCE OF THE FLUIDS OF THE BODY.

THE *fluids* which are made within the body, that wonderful factory which we have been trying to describe to you are constantly changing both as to quantity and quality. This must be perfectly plain to you, because an infant is not as large as a boy, and a boy is not as large as a man. One does not require and will not hold as much as the other. If the quantity of fluids in an infant were the same as in a man the man could not live a minute. There must be some way of increasing all the substances which are necessary to the body as the body grows, and as these substances are not found in or plastered upon the body, ready made, we must conclude that they are made within it, and therefore that the comparison of the body to a factory is a good one.

It is difficult to say which fluid of the body is more useful than the others. The body will suffer if any one of them is deficient in quantity or quality, and while some people have lived for a time after one of the important organs of the body or a portion of it has been removed or destroyed, it is difficult to believe that this is normal or thoroughly first-class living.

A portion of the liver may be destroyed, or a portion of the pancreas, large portions of the intestines may be removed, one of the kidneys may be taken away, the entire stomach may be removed, also a portion of the lung or a portion of the brain. All these things have been done by clever surgeons, and the people upon which they have been done have apparently gotten well. Nature is indeed a wonderful nurse and mother, and has to make the best of it in such cases, but of course the condition cannot be the same as when all the machinery is working in good order and doing that which it was intended to do.

Let us now interview dame Nature in her wonderful workshop or laboratory, and see what substances she is making, and find out all we can about them.

If there is any one substance or fluid made in the body which is more important than another it is the blood, in fact it is often called the vital fluid or the fluid which is essential to life.

THE BLOOD—THE VITAL FLUID, WHAT IT IS AND DOES.

I have said the blood was a fluid; it is an absolute necessity that it should be a fluid. Sometimes it becomes thickened in one or more blood vessels and ceases to flow in those vessels. Such a situation would mean death to the person who suffered from it, if the blood were not flowing in the rest of the vessels. Fortunately, in many cases of that kind, the blood current finds a new channel, leaves those vessels which have been plugged by the thickened or clotted blood to take care of themselves and the person may eventually get well. But this is not always the case, for if a portion of the thickened blood or clot is washed away and gets into the heart it may form such an obstruction that death will be the result.

Most boys know what it is to build a dam in a brook. You know that after the current has been stopped awhile and has made a pool behind the dam it is very apt to trickle out on one or both sides of the dam and form new channels. When this has taken place the pressure on the dam is relieved and the current may soon be flowing in the new channels as if nothing had happened. Something of that kind occurs when the blood-current is obstructed by the thickening or clotting of the blood in any of its vessels.

Then again, the pressure of the water in the brook sometimes breaks the dam and sweeps away the obstruction. So, too, in the body the pressure of the obstructed blood-current may break a blood vessel and let the blood out into the surrounding tissues. This is what happens when a person has apoplexy, and if it is a blood vessel in the brain which bursts, the pressure of the blood which oozes out into the brain will cause paralysis and in very many cases will cause death. After death, when the blood has ceased to flow, it becomes clotted, usually in the heart and veins. *So the first thing to remember in connection with the blood is that it must flow freely through all the blood vessels if a person is to have good health.*

THE COLOR OF THE BLOOD.

The next thing to consider about the blood is its color. If you were asked to tell its color you would probably say that it was red. That is true; but it is not always red, that is the same shade of red. If you should cut an artery and notice the blood as it spurted out, you would observe that it was a very bright red—red as a rose. If on the other hand, you have a slight cut, a mere scratch, and note the color of the blood, you will observe that it is a little darker than the blood from the artery, because it is from capillaries or veins. If you should examine the blood of a person who had been poisoned from inhaling illuminating gas, or suffocated from any cause you would see that it was almost black. The color of the blood is therefore a matter of great importance, and if it is very dark it always means that something is wrong with the person who has such blood and that it must be very quickly remedied or the person will die.

WHAT THE BLOOD IS MADE OF.

What do you suppose the blood is made of? It is not a simple substance, like springwater, by any means,

HARVEY DEMONSTRATING THE CIRCULATION OF THE BLOOD.

and it will be well worth your while to spend a few minutes with me in going into this question somewhat carefully. Suppose we have been obliged to draw off a small quantity of blood and have caught it in a glass. Hold it up to the light and it will be seen to be fluid and to be red. Now let it stand in the glass for an hour and you will observe that it is gradually thickening. A watery fluid presently begins to ooze out of this thickened mass and soon the watery portion and the thickened portion are distinct and separate from each other in the glass. The watery portion is called *serum* and the thickened portion is called a *coagulum* or clot. There is something in the serum which caused the clot to form and that is a substance called *fibrin*. While the blood is circulating in the blood vessels the fibrin does not usually cause a clot to form. It may do so in certain conditions of disease as we told you on a previous page, but that is unusual. As soon as the blood escapes from the blood vessels the fibrin acts and the clot is formed. The clot is composed of corpuscles or blood cells. You learned in the chapter on cells, you may remember, that the blood cells were of two kinds, red and white. There are many more of the red than of the white; there may be as many as three hundred of the red to one of the white. If the white cells are very numerous it means that there is disease, and perhaps very serious disease. The same is true when there are too few of the red cells. The red cells occur in the form of round bodies with an opening in the center. Discs they are sometimes called, the word meaning a quoit with which all boys are familiar, and which they very much resemble. The white cells resemble small spheres or balls.

The red cells vary in size in different animals; they are much larger in some of the lower animals than in man; the white cells are usually larger than the red. The reds are often seen in lumps or masses which look like rolls of coin, the whites are usually single, mingled among the reds. The reds move only as they are carried along with the blood current the whites have a peculiar movement of their own which is called amœboid movement that is movement like an amœba which is one of the simplest forms of animal life, composed of only one or two cells. As the white cells roll along, little prongs or feelers project from them making them look like insects in motion.

The color of the blood is due to the coloring matter in the red cells, a substance which is called hæmoglobine. They also contain oxygen and the brighter the color of the blood the more oxygen will there be in the red cells. Dark blood has not as much oxygen as it ought to have, and it has too much carbonic acid, which we may study about by and by. The red cells are often destroyed and often die, and their places are taken by white cells which have been changed into red. One of the principal objects of the red cells is to carry oxygen to the tissues of the body. But the blood contains other substances in addition to those which have been mentioned. Fat cells are found in it, especially a few hours after food has been taken. It is also found in the blood of those who are fasting, as if the body were living upon deposits of fat stored up for emergency. Such a storage supply of food as this is all the nourishment which those animals have who sleep during the entire winter and is probably the explanation of their lean and emaciated condition when the spring comes and their sleep is ended. Of course water forms a very large portion of the blood as it does of every other portion of the body; out of every ten parts of it by weight eight or nearly eight consist of water. Albumen in different forms is another ingredient of the blood. It is derived from the food which is taken into the body and digested, after which it is absorbed and carried along in the blood current to nourish the tissues of the body. It would be well to remember that the blood cells themselves are composed partly of albumen.

There are also various mineral salts which are in solution in the blood, combinations of lime, soda, potash and magnesium, common salt or sodium chloride being the most abundant. Iron is also present forming a portion of the hæmoglobine. Another interesting fact about the hæmoglobine is that under certain conditions it chrystallizes into four or six sided plates or prisms; these chrystals are not found in the blood of animals though chrystals of other forms and shapes may be found. This is often a matter of very great importance, for suppose a blood-stain were found which was believed to have come from the body of a person who had died, possibly from the body of one who had been murdered. If the chemical expert who examined this dried blood should subject it to the proper chemical tests and should find chrystals such as belong only to human blood it might furnish important evidence in clearing up the mystery concerning the dead person. If on the other hand only such chrystals were obtained as are derived from the blood or rats or mice, or guinea pigs or squirrels it would show that this particular stain probably had nothing to do with the mystery.

Let us now sum up, in a few words, the composition of the blood in its normal or natural state. While it is circulating in the blood vessels of the body it may be said to be composed of two parts, cells or corpuscles and plasma or fluid. After it has clotted it divides into two parts, the clot containing the cells and the fibrin which caused the clot to form, and the serum or fluid which contains water, fatty and albuminous material, and mineral salts. Now if you will turn back to the chapter in which you were told about the substances of which the body is composed you will find that every one of those five groups of necessary proximate or elemental principles is contained in the blood.

THE USES OF THE BLOOD.

From what has been said in regard to the composition of the blood you will realize at once that the blood contains in its current the substances which the different parts of the body require for keeping them alive and for nourishing them. As the blood vessels go to every part of the body and all the cells of the body are in some way or another in contact with the blood it will not be very hard to imagine how the cells of each kind of tissue will select or pick out from the current, as it glides along, the particular kind of food which it requires. Of course this may not be done as you would pick apples out of a basket, the processes of nutrition are not so simple as that, but directly or indirectly that is the thing which happens. The first use of the blood is therefore to nourish the body, and when it is said that a person has rich blood it simply means that it has in it an abundance of the substances which the body requires. When on the contrary it is said that a person has *thin* and *watery* blood, it means that it is deficient in those substances which the body needs. If the blood carries food to all parts of the body it may also carry poisons, and while it bears life on the one hand, it may bear death on the other.

Many people inhale illuminating gas for the purpose of suicide. This poisonous gas received into the lungs is absorbed by the blood just as the life-giving oxygen is absorbed, but while the oxygen makes the red cells bright in color and is just the kind of food they need, the illuminating gas makes them dark and presently destroys them, and the person dies quite as much for the reason that he has no oxygen as that his red cells have been destroyed. Suppose the germs of a disease got into the blood, and there are many diseases the germs of which finally get into the blood current, what happens? If there are not too many of them the white blood cells go after them as a ferret would go after a rat. If the white cell catches such a germ and is stronger than the germ it practically folds itself about it and eats it up, but if the germs are too many for the white cells, they multiply in the blood and produce their bad effects upon different parts of the body, causing sickness and perhaps death. Sometimes they develop in the blood and destroy the cells, like the *trypanosomes* of the sleeping sickness which is such a deadly disease in Africa. The same is true of the germs of malaria and many other diseases. There is one curious germ, which is in fact a minute worm called filaria, and is seldom found in the blood except at night, as if its habits were like those of the beasts of prey. For many germs the blood furnishes just the proper conditions of heat and moisture to make them develop rapidly and that is the reason why some poisons kill so quickly, like the poison of snakes, and of course it is only by getting something into the blood which will neutralize that poison or stop its growth that a fatal result can be prevented. That is the reason why a person should be inoculated with the proper antitoxin as quickly as possible in case he is so unfortunate as to be bitten by a mad dog.

The blood may also carry substances which are usually present, and are harmless when present in small quantities, but are injurious or fatal when present in large quantities. An example of such a substance is sugar, which is ordinarily present in the blood after the digestion of starchy foods, but when it is present in large quantities, as in the disease called diabetes, it frequently causes death. Further the blood may carry substances which do not belong to it, which are harmless in small quantities but harmful when in excess. Certain coloring materials, for example methylene blue, may be taken as a medicine. In the case of the methylene blue it is taken by the blood to the kidneys, is passed out with the urine which it stains a deep blue color, and if it has been taken in proper quantity may prove beneficial. If, however, too much of it has been taken it may act as a poison and do more or less harm. Thus we see that the blood may be compared to an express company which carries packages over the entire body and delivers them at the proper stations. Some of the packages contain very desirable substances which are beneficial to the parts to which they are delivered and some are harmful and may even break up the entire business.

Another use of the blood is of value in connection with criminal conduct, in addition to the value of blood chrystals about which you read on a previous page. In such a case the coloring matter or *hæmoglobine* of a blood stain or a suspected blood stain may have disappeared, and it would then be no longer possible to obtain blood crystals. But if the other portion of the red blood-cells remains this can be examined by suitable chemical and microscopical tests and the fact determined, within certain limits, whether they are the blood cells of a human being or of an animal. If, for example, the cells were oval and contained a nucleus it would be certain that the blood was that of a bird, a reptile, or a fish. If the cells were round and without a nucleus it would be possible to say that they might have come from a human being, but that there was also a possibility that they might have come from an ape, or a dog, because the red blood-cells of these animals are of about the same size as those in human beings. Such an examination therefore, while it might be of assistance, would not in all cases be convincing.

THE QUANTITY OF BLOOD IN THE BODY.

The quantity of blood in the human body is about one-tenth, by weight, of the weight of the body, so that if a person weighed one hundred and fifty pounds he would, under ordinary conditions have about fifteen pounds or fifteen pints of blood. Years ago it was a very common practice among physicians to draw blood from the body in the treatment of many diseases. It was not uncommon to withdraw a pint at a time and perhaps repeat it a number of times at suitable intervals. Sometimes it was distinctly beneficial and sometimes it was harmful.

George Washington was bled during his last illness, which was probably diphtheria lasting only one day, and as he was sixty-seven years old and a great deal of blood was withdrawn it may have hastened his end. At any rate it did him no good.

As we know that the blood carries harmful germs in so many diseases it would probably be useful in some cases to let some of them out. So it may come to pass that the practice of bleeding to relieve certain diseases may be adopted, again, but I am sure, if this should be the case that it will be followed with more wisdom and caution than it formerly was.

THE LYMPH AND CHYLE.—THE FLUID WHICH CONTAINS WORN-OUT MATERIALS AND ALSO SUBSTANCES WHICH HAVE BEEN DIGESTED AND ARE TRAVELING TO JOIN THE BLOOD CURRENT.

In these two substances we have two fluids circulating in the same set of vessels, both of them bound for the blood current, as the water of a river with all that it contains is bound for the sea. But remember that there is no chyle in the set of lymphatic vessels which I told you was in and under the skin throughout the entire body but only in the deeper set of vessels and especially in those which are connected with the intestines. The lymph when unmixed with chyle is a watery fluid, colorless or of a light amber color, the chyle is white and milky on account of the digested fat which it contains, and which has been absorbed from the small intestine. When a large quantity of chyle is mixed with the lymph the mixture is no longer clear and transparent but is discolored by the chyle. The composition of the lymph is very similar to that of the watery part or plasma of the blood. While it is composed mostly of water, nine hundred and sixty-four parts in one thousand being water, it also contains fat, mineral salts, albumen, and the peculiar substance called fibrin which will cause it to coagulate or clot, just as the blood coagulates, though there is so little of this substance in it that the clot is less firm than a blood clot. Lymph contains globules or cells obtained from the lymph glands through which the current passes, which are similar in appearance to the white blood cells, in fact it is quite generally believed that they actually are the white blood cells and nothing else. This seems the more probable since the lymph stream empties into the blood, as we have already seen.

The quantity of lymph which is poured daily into the blood currents amounts to about four pints, that is about one-quarter of the weight and volume of the blood. This informs us as to one of the means, at least, by which the volume of the blood stream is supplied. You will remember that the blood stream is constantly getting rid of the substances which are dissolved in it and of course their place must be filled in order to keep the blood pressure constant and uniform. It is like the sea, which is constantly receiving new resources from the rivers which flow into it, and as constantly getting rid of them by evaporation into the atmosphere.

THE SALIVA—THE SPITTLE WHICH KEEPS THE MOUTH MOIST AND HELPS DIGEST THE FOOD.

I suppose very few young people ever stop to think of the importance of this fluid, and yet if the supply were to be cut off, our mouth would be dry and parched, we would have the greatest difficulty in chewing our food, and we would find it very troublesome to swallow it. Not only that, but our food would be deprived of one of the substances which helps to digest it. We would also have great difficulty in talking. We have already seen that the saliva is obtained from five glands which are situated in different portions of the cavity of the mouth and it also comes from a great number of very small glands which are distributed over the mucous membrane or lining of the mouth, and of the back part of the tongue. Saliva, as it comes from the glands, is a clear transparent, rather sticky fluid, which is always present in the mouth when one is in health, but is much more abundant when the food is being chewed. The act of chewing stimulates all these glands to pour out the fluid which they contain. The fluid which comes from the little glands of the mouth and tongue is much more sticky than that which comes from the five large ones. If you were to collect a quantity of the saliva in a glass from the five glands mentioned it would first be frothy and somewhat bluish in appearance, like milk to which water has been very freely added. After it had stood and settled for several hours you would notice a sediment at the bottom of the glass, while the fluid above would be clear and transparent like water. In fact nine hundred and ninety-five parts in every thousand of saliva are water, the remainder being albuminous material and mineral salts. Our old friend, the common table salt, is there as we have found it almost everywhere else in the human body. The substance which is of most importance in the sediment which has collected in the glass is one which belongs to the group of ferments, which you will remember is in the third class of the substances which are made in the body, and is called *ptyaline.* Though there is only a very small percentage of *ptyaline* in the saliva, it has a very perceptible effect in beginning the digestion of a portion of the food which is taken into the mouth. That portion of the food which is called starch, including potatoes, peas, beans, and other vegetables is attacked by the ptyaline and a portion of it is changed into sugar.

Chewing increases the flow of saliva, and it has such an effect particularly upon the glands which are under each ear. Sweet, or spicy, or acid substances will increase the flow from the glands which are under either side of the lower jaw, while the act of swallowing is believed to increase the flow from the gland which is under the tongue. You have heard the expression that ''it makes one's mouth water'' to think of certain things, especially those things which one likes and which as we sometimes ungrammatically say ''taste good.'' This means that certain nervous impressions, increase the flow of saliva. In certain diseases, as in poisoning from the use of mercury, the saliva flows from the mouth in a steady stream, and this condition is called salivation. Certain medicines will also cause a great flow of saliva. The drug which is called *pilocarpin* makes the saliva flow so fast that one is sometimes in danger of being choked by it, for which reason doctors frequently hesitate to use it, even though it may produce other effects which are desirable. Those who chew tobacco also frequently have an abundant flow of saliva, and they do not always dispose of it in the most agreeable or polite manner. On the other hand there are some nervous impressions which will arrest the flow of saliva, and the afflicted person may say that his mouth is ''as dry as a bone.'' Fear or the receipt of bad news will sometimes produce this effect. Probably the writer in the Bible who said that ''his tongue clave to the roof of his mouth'' referred to the dryness which came with an intense nervous impression and stopped the flow of saliva. When a grown person is in a condition of health nearly three pints of saliva are secreted or manufactured every day. The most of it is mixed with the food, softening it and preparing it for digestion, while the sticky element makes the mass of food in the mouth slippery and so assists in the act of swallowing.

THE MUCUS—THE LUBRICATING SUBSTANCE WHICH KEEPS THE MUCOUS MEMBRANE MOIST AND STICKY.

Mucus is the slimy or sticky substance which is always to be found as the product of mucous membranes when they are healthy. Too little of it means disease; too much of it likewise means disease. We find both these conditions in the stomach, for example, in different forms of disease in that organ. The mucous membrane is to the inside of the body what the skin is to the outside. It lines the food canal from the mouth to the extreme end of the intestines. It also forms a lining for various organs, the kidneys, bladder, lungs, etc. It is obtained or manufactured from the cells of the glands of the mucous membrane in these different organs. These mucous glands may be extremely simple, merely a dimpling in of a few cells from the surface of the mucous membrane, like the mucous glands of the mouth of which we were telling you just a moment ago in connection with the statements about saliva, or they may be very complicated, branching in all directions like a bunch of grapes. Of course the more extensive the surface of the mucous gland the more mucus will it manufacture, for if each cell made one drop of mucus, a gland with a thousand cells would of course make much more than one with ten, or fifty, or a hundred. All the glands, large and small, are surrounded by blood vessels, and the cells of the glands soak, as it were, the proper fluid from the blood and change it into mucus. This may be considered as the usual method whether the gland be large or small, each cell acting like a little laboratory and furnishing its contribution to the output of the gland. We have said that mucus was a sticky, or slimy substance, and you can guess its purpose from that. Just as oil is necessary to make machinery run smoothly, so mucus is necessary to make mucous membranes smooth and moist. It is also necessary for mixing with certain substances in order to soften them and prepare them for certain changes which they are about to undergo. Thus it is that the mucus in the mouth mixes with and softens the food which is being chewed. Thus it is also that the food which has reached the stomach is mixed with the mucus which is awaiting it there in abundance. The mucus in the windpipe and bronchial tubes, on the other hand, protects them from irritating effects of the air. But when, for any other reason, there is too much mucus in the stomach or in the windpipe or the bronchial tubes or in any other place which is lined with a mucous membrane then we have a condition of disease called catarrh, and a very disagreeable and troublesome disease it frequently is. Here again we see the great activity of the machinery of the body. Just how much mucus per day is made by this machinery it would be very difficult to determine, but it must amount to several pints.

THE PERSPIRATION—THE FLUID WHICH KEEPS THE OUTSIDE OF THE BODY MOIST AND COOL.

It is scarcely necessary to ask if there is any one who does not know what is meant by the word perspiration, or sweat. Occasionally we see a person who does not perspire; in winter and summer his skin is dry and unnatural in its feeling. Such people are apt to be extremely uncomfortable, for however disagreeable profuse perspiration may be on a hot day, or after severe exercise or hard work, it is not half so bad as the condition of perpetual dryness which is experienced by those who have no sweat glands or who haven't enough of them. Rare indeed must be the case when these glands are entirely absent, but their number may be so small that the skin never reaches the condition of perceptible moisture. The sweat glands lie deep down in the skin, and some of them are below the skin. In a healthy adult or grown person there are about four hundred of them to the square inch on the neck and back where they are least numerous, while in other parts of the body they are much more abundant.

A sweat gland looks like a coil of rope, and from the top of it a tube goes straight up to the surface of the skin, though in some places like the palm of the hand and the sole of the foot where there are more than two thousand of the glands to the square inch, the tubes are twisted like a cork screw. The cells of the sweat glands, like those of the other glands, take their material from the blood current which is flowing in vessels which are all around them. This material is changed somewhat by the cells and is then sent to the surface of the body through the tubes which lead from the glands. The perspiration is the most like pure water or any of the secretions of the body, nine hundred and ninety-five parts in a thousand being water. Of the remaining parts, mineral salts, especially table salt, are the most abundant, while there is also an acid substance which in some persons has a disagreeable odor. Sometimes the salty taste of the perspiration is very noticeable. Probably you do not realize that perspiration is constantly going on though the skin may not be especially moist. This form of perspiration is known as insensible perspiration, and if it were not for this condition the skin would be dry and parched the most of the time. Nearly two pints of fluid pass out upon the skin daily by this means, evaporation being so constant and uniform that we are not conscious of it. But suppose a person with well-developed perspiration apparatus does hard work, or suppose it is a day in August with the mercury at 100° F, then the insensible perspiration will become very sensible, and the person will be "dripping from every pore," as the saying goes, while the moisture in his clothing, and that absorbed by handkerchiefs with which he mops his neck and face and hands, show how active the sweat glands can be, when the occasion requires. Under such conditions one can easily sweat more than half a pint of fluid in an hour.

HOW PERSPIRATION IS SOMETIMES PRODUCED OR CHECKED.

Perspiration may be produced artificially and it may be arrested artificially. You have heard of a "cold sweat" coming over a person from fear, from sudden emotion, or when death is approaching. This is because the sweat glands, which are influenced by both muscles and nerves, are relaxed. Various drugs will produce sweating, and sometimes this is an experience which is greatly to be desired, as when one drinks a bowl of hot ginger tea, for example, to cause sweating, and at the same time to break up a beginning cold. Perspiration may also be checked by fear, the nervous impression shutting up the mechanism which permits it to escape from the glands. In very cold weather the blood leaves the extremities and circulates with correspondingly greater freedom in the interior of the body; the hands and feet are then cold and the skin is dry. The importance of the perspiration in regulating the temperature of the body is very great. With a perspiring body we can bear the temperature of a Turkish bath, 120° to 130°F; when without this perspiration such a temperature might involve serious consequences. Those who experience sunstroke sometimes have a body temperature of 108° to 110°F, and unless this were quickly reduced death would result, but the freely perspiring body bears that temperature outwardly or even a much higher one, and if properly treated may not suffer, but may even be benefited by it.

THE OILY SUBSTANCES—FATS AND OTHER GREASY SUBSTANCES WITHIN OR UPON THE BODY WHICH PREVENTS DRYNESS AND ALSO ASSIST IN THE REGULATION OF THE TEMPERATURE OF THE BODY.

While much of the oily and fatty material which is within the body is introduced in the form of food there is also a considerable quantity which is made within the body. Of course the fat which is circulating in the blood has a share in the preparation of this product. The quantity of this material which is manufactured in the body is quite large and is spoken of by medical writers as *sebaceous* matter, or using the Latin word, as *sebum.* This word corresponds to our English words tallow, grease, and suet, and the sebaceous material which is found in and upon the body is quite similar in appearance to suet, though it is not so hard. It is interesting to note that this is the only form of fat, appertaining to the body, which is regularly discharged from the body. It is made in glands of a rather simple character which are situated in the deeper portion of the skin. Many of them have an opening into the glands in which the hairs are formed, while many others open directly upon the surface of the skin. They are very numerous upon the scalp and upon the face, particularly upon the nose, the end of each gland being covered in some individuals with a black speck. For this reason they are sometimes called "black-heads," they are very common in young people and also rather mortifying for they do not improve the appearance of the face. The material which these glands contain can often be squeezed out and looks like a little worm, but is absolutely nothing but fat. Ordinarily it is discharged upon the skin in sufficient quantity to keep the skin moist and smooth, thus assisting the perspiration. In some cases, however, it is discharged in great abundance and gives the skin a greasy and disagreeable appearance which is particularly objectionable in those who are careless and uncleanly in their habits.

Sometimes the openings to these glands are so firmly closed that this substance cannot get out, it must therefore accumulate and form small tumors, which are sometimes called *wens*. These tumors are of frequent occurrence upon the face and scalp; they are unsightly but are not usually painful. If, however, they become inflamed, they may get very sore and it may be necessary to remove them. Sometimes curious tumors form in the interior of the body, containing the same structures which are found in the skin, hair, teeth, nails, and perhaps a large quantity of this sebaceous material. It is not unusual to find a pound or two of it in such tumors, and it looks and feels like a mass of tallow or suet. This is the material with which the skin of a new-born baby is covered when it comes into the world, and it has served a very useful purpose in protecting the delicate skin of the infant during the period in which it was developing. It frequently accumulates also upon the skin of babies, particularly upon the scalp, in the form of unsightly scabs and crusts. This is particularly apt to be the case when babies do not get the right kind of food and are not properly nourished. Such a condition is usually the cause of great alarm to mothers, especially if the baby happens to be the first one that has come to the family. But it is not a dangerous condition, and usually yields to intelligent care. In grown people an excess of this material is often a cause of loss of the hair, together with a very annoying oiliness of the scalp.

THE GASTRIC JUICE—THE PRODUCT OF THE MACHINERY WHICH IS IN THE STOMACH.

You will remember what was told you about the shape and location of the stomach in the last chapter, and that its purpose was to receive the food which had been chewed with the teeth, moistened and softened with the saliva and mucus of the mouth until it had become a pulpy mass, and that this mass was then seized by the swallowing muscles, forced into the gullet down which it was squeezed, like grain pouring down the chute of an elevator, until it landed in the pouch on the left side of the stomach. You were also told that the lining or inner coat of the stomach was composed of mucous membrane, which is quite thick and loosely attached to the outer coats, smooth when the stomach is distended, and in folds at other times. Its inner surface has a worm-eaten or honey-combed appearance, the openings being the mouths of thousands of little glands which are scattered all over it. These glands are of two kinds; one of them manufactures mucus, like all other mucous glands, the other, called peptic glands, manufactures gastric juice. This is an acid or sour fluid which is poured out from the glands into the stomach only when there is food in the stomach for it to act upon. It contains nine hundred and seventy-five parts of water in a thousand, also hydrochloric acid, pepsine, and mineral salts; table salt as in the cases previously mentioned being the most abundant.

Now the object of the gastric juice is to digest or liquify the food and prepare it for absorption by the blood vessels. But note this fact, it does not attack all food with which it comes in contact, but only albuminous substances such as meat, eggs, and cheese, which have already been partially prepared by chewing, and by moistening with the saliva. The starches and fats must go further than the stomach before they can find the ferment which will reduce them to a condition in which absorption into the blood will be possible. It takes about three hours for the gastric juice to act upon the albuminous material which is eaten with an ordinary meal, provided it has been well cooked and thoroughly chewed. It takes considerably longer if the food is raw and is swallowed without being thoroughly chewed, so you see how necessary it is that these things should be done if you desire to help digestion. The stomach is in motion like an old-fashioned churn while the food which it contains is being digested, and a small stream of digested and undigested food is constantly flowing out of the end of the stomach called the *pylorus* or gateway, into the small intestine from the time that digestion begins until the stomach has emptied itself of its contents. The flow of the gastric juice into the stomach begins as soon as the stomach is excited by the presence of food, and continues as long as any albuminous material remains undigested. Not all the gastric juice which is poured out is used in digesting the food, that which remains unused goes with the current of the food into the intestine and is there re-absorbed, and either broken up in its further passage with the blood current or re-deposited in the peptic glands for further use. It is estimated that about six pints of gastric juice are poured daily into the stomach of an adult person, which gives us additional evidence of the great activity of the mill which is working within us as long as life continues. Of course the gastric juice is not always as abundant or as efficient in digesting food as it ought to be, and, it is very interesting to know that we can help nature in such a plight by obtaining pepsin from the stomach of animals which have been killed, such as cows, sheep, and pigs, combining it if necessary with hydrochloric acid, and giving it to the person who is suffering with indigestion.

Such a material seems to answer the purpose just as well as if it were provided in the natural way.

The secretion of gastric juice may be influenced by various conditions; if one is angry, or irritated, or worried at the time of eating, the gastric juice will not be poured out, and as a consequence digestion will not take place, and the same is true if one is suffering from fever or other illness. *This teaches us that digestion is a very sensitive process and that if we wish to have good health we must be as free as possible from such disturbing conditions.*

THE PANCREATIC JUICE—THE POWERFUL FERMENT WHICH DIGESTS STARCH AND FAT, AND ALBUMEN ALSO TO A LIMITED DEGREE.

This fluid is obtained from the small organ called the *pancreas* or sweetbread which lies under the stomach and has a duct or tube which is connected with the first portion or beginning of the small intestine. Through this tube the fluid is poured into the intestine upon the food which has arrived there after passing through the stomach. It is a sticky, watery fluid, but only nine hundred parts in one thousand are water. It is much stronger, as a digestive fluid than the gastric juice, for it contains ninety parts per thousand of albuminoid substances and ten of mineral salts, of which more than seven are table salt. There are several substances in the pancreatic juice which produce digestion, the two principal ones being known as *pancreatine,* and *trypsine.* The trypsine attacks the albuminoid substances which have come to the intestine from the stomach, and have not been wholly digested by the gastric juice. The pancreatine dissolves or melts the starchy foods, like potatoes, peas, beans, and other vegetables, and changes them into liquid sugar or glucose. Another ferment in the pancreatic juice attacks the particles of fat which may be in the food, breaking them up into very fine particles, and so forming what is known as an emulsion.

Fat in its ordinary condition will not be taken up by the absorbent vessels and carried into the blood, but when it is in the form of an emulsion it will be so absorbed, and it is well to remember that the fat which is circulating in the blood is in the form just mentioned.

The quantity of fluid which is made by the pancreas per day is, of course, much smaller than that which is made by the stomach. Nor should we expect it to be otherwise for as we have already seen it weighs only about three ounces. It is estimated that the pancrease of a full-grown man of ordinary size will manufacture nearly a pint of this fluid daily, and as this is five times its weight it seems to me that this is a pretty good output of work. When fat has been digested by the action of the pancreatic juice the emulsion which is obtained also receives the name of *chyle.* It looks somewhat like milk, and you will remember that we learned that it was absorbed by a set of the lymphatic vessels called *lacteals,* on account of the milky appearance of the fluid which is in them, and also that it was carried by the lymphatic vessels with the lymph and poured into the blood current through two large vessels which empty into two large veins under the collar bones. When we remember that starches and fats form more than half the total quantity of the food which is taken daily by most of us, and nearly all the food which is taken by the millions of Chinese, Hindus, and others who live almost wholly upon rice, we can begin to realize the tremendous importance of this little organ.

The pancreas is frequently the seat of disease. I have seen a large tumor which grew from it, and it is not infrequently the seat of cancer. Surgeons have removed parts of it, and the patients have survived, but it is hardly probable that one could live very long if it were entirely removed.

THE BILE—THE FLUID WHICH IS MADE BY THE LARGEST ORGAN IN THE BODY.

The work of the liver is quite different from that which is performed by the stomach and pancreas. Those organs prepare their fluid only when there is food to be digested after which they remain quiet and inactive until the next meal calls upon them for another supply. The liver not only prepares its fluid to help out in the work of digestion but it stores up a certain amount of material to be used as the requirements of the body call for it. In order to understand the work and the product of the liver we must know something about its construction as a machine. It is first divided into five portions of different sizes, called *lobes;* each of these lobes is composed of a great number of tiny structures called lobules; around each lobule is a network of small veins which send branches to the veins of the adjoining lobules and other branches into its interior which meet in a somewhat larger branch at its center. This large vein has a branch which passes out of the lobule and joins the veins which have come out of the adjoining lobules. Within each lobule are a number of five or six-sided liver cells and these cells are more or less surrounded by the little veins which have entered the lobule from the network which surrounds it. If you can fix this description of a single lobule in your mind you will then have a picture of this part of the working portion of the entire liver.

The blood current flows to the lobule through the network of veins which surround it, then into its interior through the veins which surround the cells and then starts on its way out of the lobule through the large vein in the center. But this does not tell us about the fluid which is made in the cells, which is called *bile,* just as the fluid made in the cells of the mucous membrane of the stomach is called *gastric juice,* and the fluid which is made in the cells of the pancreas is called *pancreatic juice.* Nor does it tell us how the bile gets out of the liver. In addition to the veins which go into the lobules and around the cells there are little ducts or tubes which pass between the cells, and these tubes gather up the drops of bile from the cells, pass out of the lobule into the network of tubes which, in company with the network of veins, surround the lobules, then forming larger and larger tubes until they finally meet in two large tubes which pass out of the under surface of the liver, and unite in a single one which finally empties its product into the first portion of the small intestine just above the tube which empties the pancreatic fluid into the intestine. An inch and a half from the point where the two large tubes unite, a branch is given off which leads to a little bag under the liver which is called the gall bladder, and which you were told about in a previous chapter. When there is more bile than required in the intestine it is probable that the surplus is side-tracked into the gall bladder, or else backs up into it again from the lower portion of the bile tube, there to be kept until it is needed, or to be absorbed or dried up. Now that we have seen the arrangement of the vessels which bring the blood to the liver cells, thus providing the materials from which the cells make the bile, and the arrangement of the vessels which carry the bile out of the liver after it has been made, let us endeavor to find out something about the bile itself. It is a clear, sticky, watery fluid, with nine hundred and seventy-seven parts of water in one thousand of bile, and has a rather dark green color. It contains several substances which are peculiar to bile and are called bile salts, a little fat, a little organic matter of other kinds, and a very small percentage of mineral salts, of which our old friend table salt is, as usual, the most abundant. It is believed that the liver cells are working and preparing bile all the time, though they work harder and prepare more of it when the digestion of food is going on. Furthermore, bile can be found in the intestine at almost any time, though it is most abundant during the three or four hours which follow a meal. During the entire twenty-four hours it is probable that an adult person in good health and weighing one hundred and thirty to one hundred and forty pounds will manufacture about two pints of bile.

HOW THE BILE HELPS THE FOOD.

Just what effect the bile has upon the food seems to be undecided. It dilutes the food which has come out of the stomach, and it may help the pancreatic juice in digesting starches and fats, but it is not nearly as powerful in its action as a ferment as either the pancreatic juice or the gastric juice. It stimulates the intestine to contract and squeeze its contents forward and downward which is, of course, absolutely necessary to their complete digestion and absorption. Of one thing we are certain, however, and that is that the bile is in some way absolutely essential to good health, for when the doctor has every reason to believe that the liver is not making as much bile as it ought to, and gives medicine which is known to increase its quantity and stir the sluggish liver up, as we sometimes say, the person who takes the medicine very often gets well.

THE INTESTINAL JUICE—THE DIGESTIVE FLUID WHICH IS MADE IN THE GLANDS OF THE SMALL INTESTINE.

The small intestine, as already pointed out, is a round or cylindrical tube which begins on the right side of the upper portion of the abdominal cavity where the stomach ends, and passes back and forth, up and down, through the middle and lower portion of that cavity ending in the lower portion of the right side where it is joined to the large intestine. It is about twenty feet in length. All over its inner coat or mucous membrane are distributed great numbers of little glands, the most of which are nothing but very small tubes with a network of very minute vessels on the outside and an inner lining of cells in which the intestinal juice is made. This juice is a clear, watery fluid, slightly yellow in color, and far less important or efficient in digesting food than either the gastric or the pancreatic juice. In one thousand parts of this juice nine hundred and eighty-one are water, only four and a half are substances which would digest food, and the remainder consists of different kinds of mineral salts. The quantity of this fluid which is made per day is not large, especially when we consider the large extent of surface from which it is obtained, probably not more than a pint, if indeed there is as much as that. Its principal action consists in changing starch into sugar which it does very slowly. It also has the power of making an emulsion of fats, which consist in breaking up the fat into very small particles so that they can be absorbed. Coming as it does after most of the food has already been digested it seems to be intended to help out or to finish the work which has been nearly completed. It must be remembered also that more or less of the pancreatic and gastric juice still clings to the food after it has reached the intestine and continues its work as long as anything remains which it has the ability to digest.

The intestinal juice being a sticky fluid also makes the surface of the mucous membrane of the intestine smooth and slippery so that the food current will flow along more readily than if it were moving over a dry surface. There are also glands in the large intestine which are similar in form to those which are in the small intestine, but there are comparatively few of them, and the juice which they make has very little effect upon the substances which pass over them. In fact when the food current reaches the large intestine it may be said that digestion has been completed. All that could be absorbed into the blood has already been absorbed, and that which remains is unfit for use as food and is squeezed along until it reaches the reservoir at the end of the large intestine, which is called the *rectum,* and is kept there until the time arrives when one has the desire to expel it out of the body.

THE WASTE SUBSTANCES WHICH WOULD POISON THE BODY IF NOT REMOVED FROM IT.

It is quite unfortunate, boys and girls, that many people in the world always ''have something the matter with them.'' Perhaps it is a good thing for the doctors' business, for you know it is an ''ill wind that blows nobody any good.'' But any physician will tell you that many physical troubles might be avoided if people would only use a little common sense and not abuse the laws of nature. Some of the things we are endeavoring to make plain to you, may not be as interesting in some ways as ''Robinson Crusoe'' or ''Treasure Island,'' *but they are far more important for you to know* if you wish to keep strong and well.

The material which has passed through the intestine undigested and which accumulates in the rectum consists of substances which have resisted the action of the different digestive juices. Of course these juices are too weak, in some instances, for ordinary digestive purposes. If a person is sick with fever or any severe illness these juices would not have the same power that they have when one is well even if there were a desire for the ordinary food which, as you well know, is absent. Then again, too many people, especially children and young people, *swallow their food without carefully chewing it,* and others are unable to chew it carefully on account of defective teeth. When large chunks of meat, fat, bread, etc., are presented to these juices to dissolve and liquify you can easily understand that the job is too hard. Consequently such persons are very apt to suffer with *indigestion* and *constipation,* which frequently lead to other troubles. Again, there are some substances in the food which are too tough and firm to yield to digestive fluids, such as gristle and fascia, the outside covering of certain vegetables, woody fiber, etc. Children are very much in the habit of eating and swallowing substances which cannot be digested such as buttons, bits of bone, pieces of wood, bark, grass and many other things which would never be swallowed by one who realized what harm they might do.

These substances are passed out of the intestine of course, in the same condition in which they were swallowed, because they could not be digested. They often have, however, a coating of mucus which they have gathered on their journey through the intestines. The object of food being to nourish the body, such substances as are found to be injurious and indigestible should always be avoided by those who have good sense, for with a little care and perseverance plenty of food substances can be selected which will be digested and assimilated, and used by the body cells to sustain their life. A full-grown man should have a daily evacuation from the bowels which will weigh five ounces. In a healthy person this will consist of three parts water and one part solid matter. The solid matter will consist in part of the undigested and indigestible materials which have been taken in at the mouth, and in part of mucus and other substances from the large intestine, coloring matter from the bile, and mineral salts obtained partly from the mineral elements of the food and partly from the intestinal juices. Examination of the waste material discharged from the intestines, both chemically and microscopically, is now regarded as a very important step in the study of various diseases, especially those which are concerned with digestion.

THE URINE.

The urine like the contents of the intestines is a waste substance which is held in storage in the bladder, until the brain receives a message that it is desirable to expel it. It differs from the waste material in the intestines in the fact that it could not, under any circumstances, be of any service in the nutrition of the body. It represents only material which is worn out and which, if kept for any length of time within the body must do great harm and even destroy life. Only when the urine is sufficiently abundant and contains the waste matters of the body in sufficient quantity can the body be healthy. It is therefore essential to know the most important facts which relate to it. It is obtained, as you are aware, from the kidneys, the most remarkable and perfect machines ever constructed, with a system of tubes and filters more complicated and effective than any which have been made by man, so far as my knowledge goes. You know how it is in the water works of many of our cities, the water being collected in a reservoir and passed through a filtering bed before it goes into the distributing pipes. This filtering bed is composed of sand, charcoal, pebbles, etc., and as the water works its way through it, it leaves behind the substances which make it impure and unfit for drinking. The blood goes through a somewhat similar process in passing through the system of vessels in the kidneys, the urine being screened out while the purified blood goes on its course. The urine is first collected in a small chamber in the center of the kidney, called its pelvis or basin, a word which you will remember was also used in connection with another portion of the body. This basin holds about a tablespoonful of urine which then passes through the tube called the ureter, in a downward direction to the lower portion of the bladder. It is almost constantly flowing into the bladder, drop by drop, and one who is accustomed to examining the bladder with suitable instruments can easily see it as it enters. It is a watery fluid, usually of some shade of yellow in color, clear and transparent when one is in health, but capable of being entirely changed in appearance and in the elements of which it is composed, according as one is sick or well. About two and a half pints per day should be passed by a grown person who is in good health. In one thousand parts of healthy urine, nine hundred and fifty are water, twenty-nine organic matter, which is explained in the chapter relating to the substances of which the body is composed, while the remainder consists of mineral salts, table salt again being the most abundant. By far the most important and most abundant of the solid substances which are found in the urine is that which is called *urea*. This substance is very poisonous; it is not made in the kidneys but is filtered out of the blood. When there is a great deal of it in the blood it acts as a poison, and the poisoning may be severe enough to cause convulsions and death. Only when the kidneys are in good working order and remove it from the blood can a person be said to have good health. In severe disease of the kidneys this cannot be done, and death results.

There are other important substances which are not found in the urine of healthy people, but are present when there is disease, and are of great importance in telling us about the disease from which the individual from whom the urine was taken is suffering. One of these substances is *glucose,* or sugar, which is a characteristic product of the disease called *diabetes.* If we examine the urine of a person who is suspected of having this disease by the proper chemical tests and find only a small quantity of sugar it need not alarm us, but it should put us on our guard and impel us to examine the urine frequently and also study the person carefully to see whether the disease really exists or whether the sugar is merely of accidental or occasional appearance. If sugar is present in large quantities it means that a large quantity is circulating in the blood, and that careful treatment, will be necessary to arrest its excessive formation by means of diet, medicines, etc., or the person will emaciate, become very weak, and die.

Young persons who have diabetes are much more likely to die from it than those who are in middle or advanced life. The point to be remembered is that once sugar has been detected in the urine the individual must be carefully guarded forever afterward, for diabetes is like the thief in the night, you can never tell at what hour he will come. Another substance which is found in the urine even much more frequently than sugar is albumen. A trace, that is a very small quantity of albumen, is occasionally found in the urine of those who to all appearances are in perfect health, but in some persons the appearance of even a small quantity may mean that serious disease is present. You will recall that I told you that albumen is one of the constant elements of the blood. It should not pass out of the blood into the kidneys and so into the urine. When it does you may depend upon it that there is something wrong with the individual. Frequently it it the evidence of disease of the kidneys, and with the albumen we are apt to find portions of the filtering apparatus of the kidneys. Sometimes it tells us that a tumor is pressing upon the kidneys and is a kind of cry for help. It very often happens that the doctor cannot relieve the distress of the kidneys until the tumor has been removed. In some instances we can determine the presence of disease of the liver by finding some of the coloring matter of the bile in the urine. The urine may also be discolored by certain substances which may be taken as medicines. For example if the substance called methylene blue is taken it will stain the urine a deep blue. If carbolic acid is taken the urine will have a smoky appearance, and this is the way we can tell that it has been taken, perhaps with the intention of committing suicide. Other substances which may be taken as food or medicine can be found afterward, or a portion of them, in the urine, showing that the body could not make use of all that was given. Thus, quinine, iodine, asparagus, etc., can easily be detected by using the proper chemical tests. The urine also becomes a valuable means of information to us by studying with the microscope the sediment which settles after it has stood for some hours. In this way we can often detect chrystals of various substances which sometimes indicate disease and sometimes do not. We can also detect the presence of blood, mucus, pus, and various other substances. In fact the study of the urine is one of very great importance and is of very great assistance to the doctor not only in discovering disease of the bladder and kidneys but often of other organs of the body.

THE MILK—THE UNIVERSAL ARTICLE OF FOOD, ESPECIALLY IN THE PERIOD OF INFANCY.

One of the most important fluids which is manufactured within the body is milk. Every animal which belongs to the division called *mammalia,* which means animals which have breasts, nourishes its young by means of fluid which is made within the breasts, and which in all cases may be called milk. It may be interesting for you to know that this division of animals is a very large one, and includes not only an enormous number of varieties of land animals, but also many which live in the sea. Among the latter may be mentioned whales, seals, and walruses. The breasts in human beings are called by anatomists the mammary glands, and it is somewhat singular that the formation of these glands is practically the same in men and women. We have told you that a gland was a structure or machine the object of which was to take certain substances out of the blood and make them into another kind of substance, usually a fluid, which is called a secretion. The mammary glands are composed of masses or lumps of cells surrounded by blood-vessels, from the blood in which the cells take the necessary materials for the formation of the milk. The lumps of cells are connected with little tubes, and as these tubes come together they gradually form larger tubes, finally combining in fifteen or twenty good sized tubes called milk ducts which open upon a cone-shaped structure called the nipple upon the top of the breast. The gland is surrounded by an abundance of fat and held in place by a tough, strong membrane called fibrous tissue. The milk which is formed in the gland flows into the tubes and finally out of the nipple. Usually, as you know, for you have all seen a baby nursing at its mother's breast, it has to be drawn out or squeezed out, as it is squeezed by the milkman from the cow's breast, but, if the breast should be very full the pressure may be sufficient to cause it to leak out. The presence of milk in the breasts usually means that it is intended for the nourishment of a baby, but this is not always the case, for otherwise cows would only give milk when they have a calf to feed. Stranger yet, cases have been known in which men have had milk in their breasts and were even able to nurse a baby. What may seem still more strange, it is not so very unusual for a baby to have milk, or something which is quite similar to it, in its breasts, when it comes into the world, which may be a hint as to the material which it takes from its mother's blood for its nourishment, during the months when it is developing within the mother's body.

The milk which comes from a woman's breast is a thin, watery fluid, usually thinner and not so white as cows' milk. It contains a little more sugar than cows' milk, less butter or fat, and much less caseine or cheese. It is the cheese in cows' milk which is difficult for babies to digest, and it must be diluted or weakened, especially with very young babies if we expect them to thrive upon that kind of food. The materials of which human milk is composed are now so well known, and also the proportions of each material that the problem for the doctor is to make cows' milk resemble human milk as closely as possible whenever the mother is unable to feed it in the natural way, which is almost always the best.

Of course the quality of the milk which comes from different breasts varies greatly, and also the quantity which is made by them. No matter how much milk a mother may have it sometimes fails to agree with her baby, and then it becomes necessary to try something else.

The milk, like the blood, contains all the elements which are necessary to sustain life, the water, the fat, the albumen, and the mineral matter.

The quantity of milk which a healthy woman makes per day varies from one to two pints, the quantity and the quality depending upon many causes. As the baby grows the quantity increases, and about the time the baby's teeth appear the quantity begins to diminish, until finally the supply ceases altogether. It is often possible to increase the supply by suitable diet and other means, and it may be entirely arrested in various ways. Sometimes it is suddenly stopped, especially by impressions upon the nervous system, like grief, or fear, and also by various forms of sickness.

THE TEARS—THE FLUID WHICH MOISTENS THE EYES, AND IS FREQUENTLY AN EXPRESSION OF THE EMOTIONS.

The chief object of the tears is the moistening of the mucous membrane called the *conjunctiva* which covers the front of the eye. It is absolutely necessary for the health of the eye and the proper exercise of the sense of vision, that this membrane should be kept moist. The tears are made in glands of an oval shape, about as large as an almond, one of which is placed in the upper and outer part of each of the cavities called the orbit, in which the eyeball is located. Connected with each gland are a number of little tubes which open upon the upper part of the mucous membrane which we have just mentioned. Through these openings the tears trickle, passing over the front of the eye to be collected in two little tubes on the inner side of each nostril, and deposited in a little reservoir called the lachrymal sac. From this sac they flow down a little tube on the inner side of each nostril. Under ordinary circumstances the flow of tears is barely sufficient to keep the mucous membrane moist, but sometimes it is too abundant to be disposed of in this way. When you have an attack of weeping you all know that the tears overflow like the overflow of a pail of water, and when you have a cold in the head the same thing takes place, or they may flow down into the nose and keep you very busy with your handkerchief. If the little tube in the nose becomes obstructed, as is often the case, the tears overflow in the eye and it may be necessary to pass an instrument from the eye into the nose to remove the obstruction. The flow of tears is very dependent upon the nervous system and a sudden emotion will sometimes bring a gush of them to the surface, like a sudden shower of rain in the summer. Some people have a habit of shedding tears very copiously, while with others there may never be more than are required for the moistening of the *conjunctiva.* The tears, like all secretions contain more or less organic matter, and if you will collect a quantity of them and let them dry you will find chrystals of mineral matter remaining, including table salt.

THE HAIR—THE COVERING OF THE SKIN WHICH PROTECTS IT FROM EXTREMES IN TEMPERATURE.

We have already learned something about the hair and the way it grows within the skin and out from it. It is well to think of the hair as really a part of the skin, for its structure is practically the same as the outer layer or coat of the skin. There are very few portions of the body where there are no hair follicles or glands from which the hairs grow. The palms of the hands and the soles of the feet never have hair glands, at least I have never yet heard of a person who had them in these locations. Such a person would be a greater curiosity than one who had no hair glands or at least no hair at all, and I have seen several such persons.

The hairs as you know differ greatly in their strength and color, some are very coarse, some are as fine as silk, some so short that they scarcely get beyond the skin, and some so long, on the scalp of women and the face of men, that they can be coiled up into many folds. The color of the hair is due to granules of pigment which are in the hair gland and are pushed upward with the other cells by which the growth of the hair is continued. The hair glands or follicles are supplied with vessels and nerves like all other glandular structures, and derive their nourishment from them. We told you on a previous page something in regard to the sebaceous or grease glands which are connected with the hair glands and supply them with lubricating material, thus keeping the hairs moist and oily instead of brittle as they would otherwise be. Connected also with the hair follicles are very small bundles of muscular tissue. When these muscle bundles contract the contraction causes the hair to rise. You have probably heard of people whose hair ''stands on end'' under the influence of great fear. In so far as the hair moves at all its motion is due to the contraction of these little bundles of muscle.

THE NAILS—THE PROTECTION FOR THE ENDS OF THE FINGERS AND TOES.

The nails are merely the continuation of the outer or horny layer of the skin. There is a groove on the back of each finger and toe over which is spread the *matrix* or portion of the skin from which the nails grow. The nail consists of a number of layers of cells, one layer being closely united to another and these are being constantly pushed forward and upward from below, to take the place of the end which has been worn off or cut off. The outer layers of cells are more compact, harder, and more like horn than those which are nearer the matrix. Within the matrix are a multitude of projections looking like little cones, under a magnifying glass. They have blood vessels and nerves and nourish the cells of the matrix from which new cells are constantly being developed. The anatomists call these little cones papillæ and they are wonderfully sensitive, particularly to impressions of pain. If you ever had a nail pulled out or even pared down too closely you will know how acutely painful such an experience is. Similarly acute is the pain which results from running a sliver of wood deeply under the nail, the explanation in all these accidents being that you have bruised or cut the end of nerves which produce sensation and are called sensory nerves.

We have now finished our brief consideration of the substances which are made in this wonderful workshop of the human body. There is no other workshop which can be compared with it in the variety and excellence of its product and the ingenious nature of its machinery. The older you grow and the more you know about the structure of your body, the more you will realize how great is the Wisdom which planned it all. In the next chapter we will look a little further into the question of the work of the various parts of the body, and you may learn some new things about yourself which will be of great benefit to you later on if carefully stored in your memory while your are young.

CHAPTER X.

What the Various Parts of the Body are For and the Work which They Have to Do.

THE BODY A MACHINE WE SHOULD UNDERSTAND.

WHEN a man buys an automobile, the first question which he asks himself consciously or unconsciously is—What am I going to do with it? Many of us are very ignorant in regard to machinery. We couldn't run an automobile with safety if our lives depended upon it, but inasmuch as many thousands of people are running automobiles it must be that the machinery is not so complicated and difficult to understand but that we might be able to overcome the difficulties and drive the machine with safety if only we had a little patience and applied ourselves diligently to the mastery of the mechanical problems which were involved. The machine would be a great deal more useful to us if we understood it thoroughly from A to Z, than if we trusted ourselves to the knowledge of others.

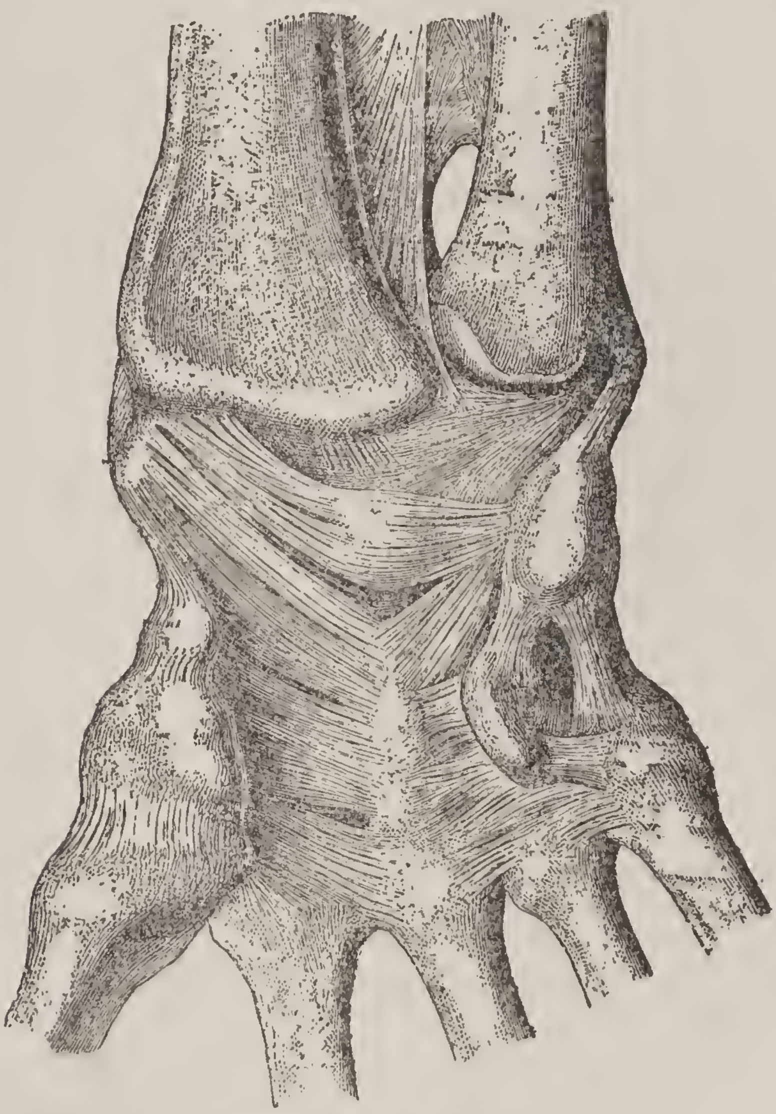
Now is it not very much the same with the wonderful machine which each one of us owns, even if we do not own an automobile? We see what a fine machine it is, how excellent it is when in action, and if we *understood its action and the working of its machinery* we could certainly get more valuable results from it than we could without such knowledge, just as we could from a thorough knowledge of the automobile.

THE FRAMEWORK OF THE HUMAN HOUSE—THE BONES, LIGAMENTS, JOINTS, CARTILAGES AND MUSCLES; WHAT THEY ARE AND WHAT THEY DO.

These structures make up the framework of the human house and the principal part of its covering, for we are considering with the muscles, the tendons and fasciæ by which they are attached and held in position. As we look at the skeleton and see the strength of the various bones, and the firmness with which they are held together by the ligaments and compare them, perhaps, as a whole, with the elevated railroad in New York City, upon which thousands of boys and girls ride every day, we conclude that it must be made to sustain weight and to carry burdens. Some men do not weigh much more than a hundred pounds, and some weigh three hundred. It might easily happen that the bones of the first were no larger and no stronger than those of the second. The bones themselves weigh but a few pounds, but they must be strong enough to carry a weight of one hundred pounds or, if necessary, of three hundred pounds. They must also be strong enough to bear heavy burdens. We often see men with a trunk on their back or shoulder, which may weigh one or two hundred pounds. These men must not only carry the weight of their own body, but that of the heavy trunk also, and they would be crushed unless their bones were strong and firm, almost as strong as iron or stone. There is a disease called *osteo-malakia* in which the bones do not contain as much lime as they ought to have, and are so soft that they will not bear even the weight of the body. Those who have this disease are helpless and unable to do the ordinary work of life.

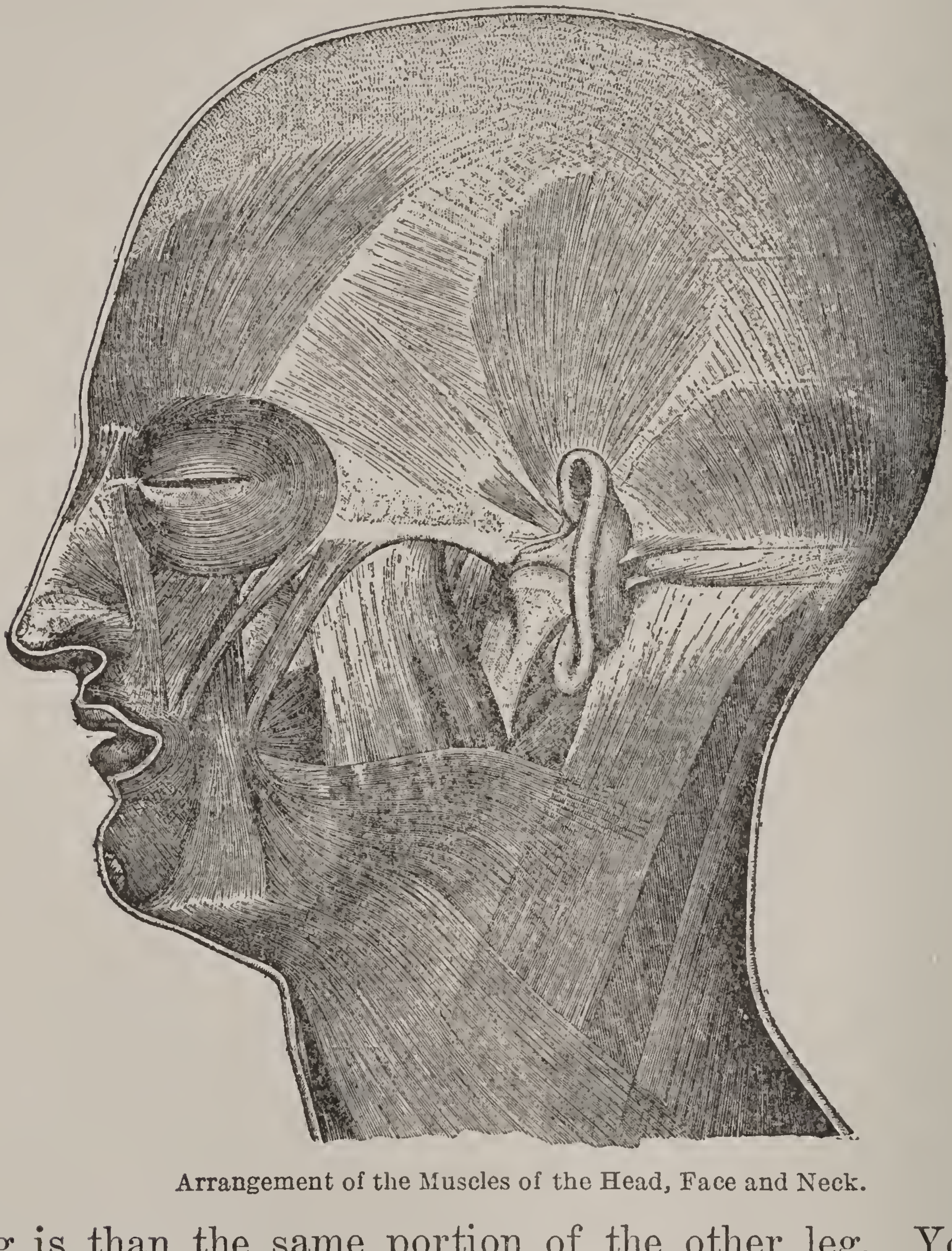
The bones are also intended for protection and some of them are evidently designed for that purpose more than others. The bones of the skull are so put together that it is almost impossible to pull them apart. They present a convex or bulging surface on the outside, and by this arrangement will sustain a heavier weight, and bear a heavier blow than the same bones would if disconnected and placed on a flat surface. The bones of the skull in some people, especially in the negro race, are so thick and strong that you could scarcely break them with a hammer. Next notice the bones of the pelvis or the haunch bones. They are very thick and enormously strong. It is the rarest thing in the world for one of them to be broken. Only in such an accident as being caught between two railroad cars, or underneath a falling building, or in some similar tremendously crushing force can they be broken. Now it seems to me there is an object in having these bones so very strong. The first variety protects that organ without which every one of us would be helpless, unable to do the ordinary work of life, unable even to attend to our simplest wants. Have you ever seen an idiot? You know what an empty, pitiable expression he has, and how unable he is to do anything which ordinary people can do. What does it mean? It means that his brain is not developed, or that it is not working properly. How absolutely essential the brain is, therefore, and how wise the provision that it is protected by such strong bones. The second variety, the haunch bones, form the cavity as we told you, in which are the organs which preserve the race from destruction. The skull contains the organ which enables an individual to get a living and to do the great things of life. The pelvis contains the organs without which life could not be reproduced, and so it seems to me the plan was a very wise one which placed unusual safeguards around these organs, even more than around those which are concerned with the feeding and other important functions of the body.

Another most important work which the framework of the body has to perform is motion. This does not mean merely the changing of the situation of the body from one place to another, but any change from a condition of rest. In the motions of the body not only the bones and ligaments are engaged but the muscles with their tendons and fasciæ, the joints and cartilages, and sometimes, as we have told you, the skin and the hair. How is motion accomplished? Principally by the contraction or shortening of muscular tissue. Many of the muscles are attached by tendons to bones; where the pull begins, being the origin of the muscle, the place where it ends—the insertion. Let us take an example or two. There is a large muscle on either side of the neck whose origin or place for pull is at the top of the breast bone and the adjoining portion of the collar bone, and its insertion or place of resistance on the bone under the ear. Place the fingers of your left hand at the insertion of this muscle on the left side of the neck, and the fingers of your right hand at the origin of the same muscle. Now bend your head as far as you can to the left side. What has happened? The muscle has shortened, it has become much harder than when at rest, and it has



Back of the Hand, Wrist, Lower Ends of Bones of the Forearm, Ligaments.

pulled the head over to the left side, that is it has produced motion. Let us take another example. Bend your right leg as far back as possible, but not bending it above the knee. Now pass your hand along the leg from the ankle up, and observe how much harder the leg is than the same portion of the other leg. You have contracted the muscles of the leg, and shortened them, and produced motion but you have also moved the knee joint in the same way that a hinge is moved. You have seen tailors sitting at their work, cross-legged. In order to get that position

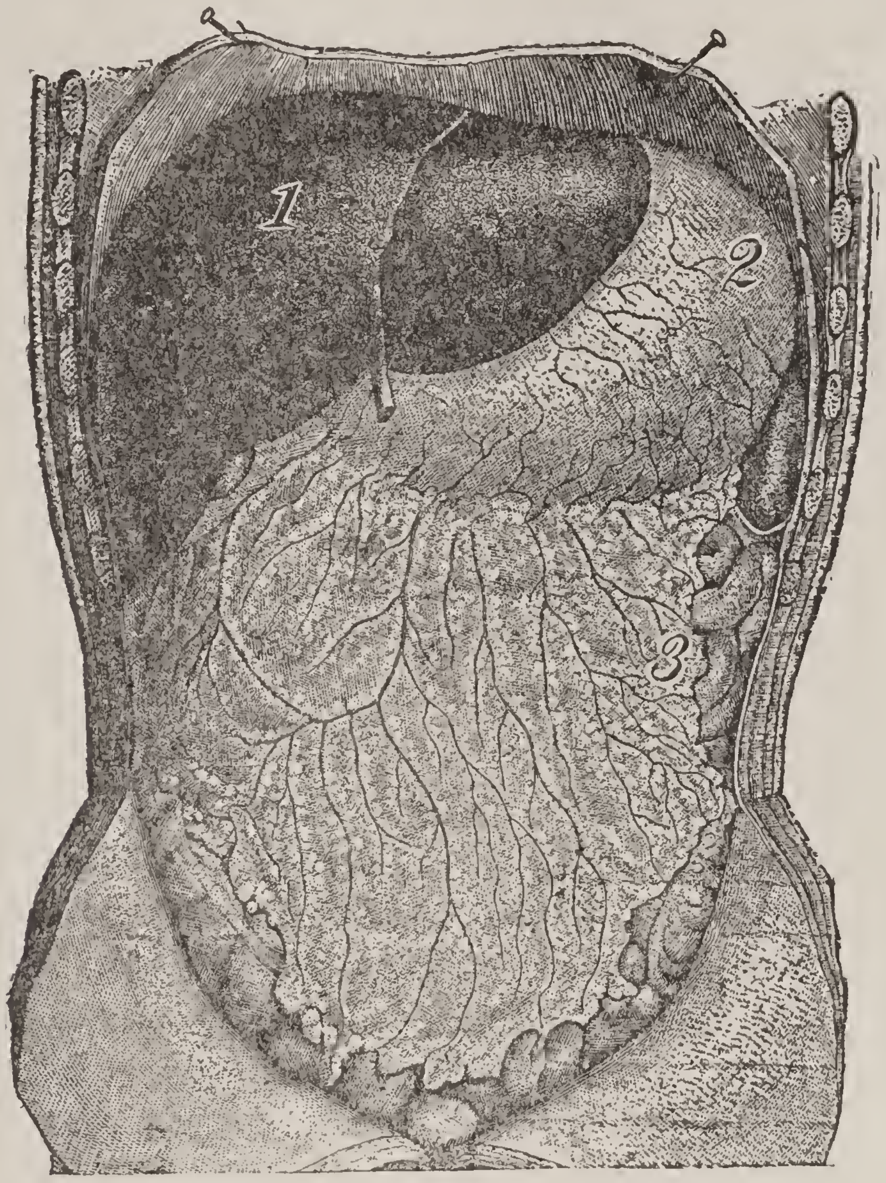


Arrangement of the Muscles of the Head, Face and Neck.

they must contract or shorten a muscle on each thigh which has its origin at the upper and outer part of the thigh bone, and its insertion at the lower and inner portion. Its pull must therefore be, not up and down but diagonal or cross-wise. It is even called the tailor's muscle. At the same time it causes the top of the thigh bone to make a quarter of a turn in its socket, so that we not only have motion of the muscle, but also of the ball and socket joint and the bones which unite to make the joint. Why doesn't the head of the bone slip out of its socket when it is twisted around? Because it is protected by the tough and firm ligament which surrounds the joint, and also by another ligament which fastens the head to the socket. It would require very great force to tear apart the ligament which surrounds a joint, and separate the bones from each other. Motion is also favored by the cartilage which is attached to the ends of bones and prevents them from coming together too forcibly in walking, running, jumping, and falling. You have noticed acrobats who turn somersaults, leap from high places, or take long and difficult jumps, and if they have been properly trained they land on their feet with as much ease and comfort as if they had India rubber on the bottom of their feet and in all their joints. And indeed their cartilages are the best kind of India rubber, and so take up the shock when the weight of their body strikes the ground that they feel no discomfort from what would give you or me a very severe shaking up. The human building is therefore very different from the one which is made by mechanics for it moves about wherever and whenever it chooses, it makes the most simple or the most complicated movements, it walks, runs, leaps, dances by means of the structures in the lower extremities, uses its hands and arms for the work which they have to perform from morning till night, moves its body and its head in all directions, rolls its eyes, uses the muscles of the throat in the complicated act of swallowing, and with proper training performs many wonderful acts which to most of us seem very marvelous, and without such training would be impossible.

THE OUTER COVERINGS OF THE BODY—THE FAT AND SKIN, ETC.

These structures form the outer covering of the body, as shingles, or clapboards, or stucco forms the outer covering of a house. They are intended both for ornament and for use. The fat which is distributed over the entire body acts first to equalize the temperature of the different parts of the body. You know the builder sometimes puts a layer of heavy paper between the frame of a house and its outer covering. The object of this is that being a nonconductor, that is being indifferent to the action of heat and cold, it may keep out cold in the winter and heat in the summer and so make the house more comfortable as a dwelling. The fatty layer does the same for the body, and though neither the fat nor the paper acts perfectly, for if it did we would never be too cold, they make us much more comfortable than we would be without them. Another use of the fat is as a padding to fill up cavities. You would be surprised to see what a hollow there is under each arm, around each eye, around each breast, around each kidney and in many other places were it not for the fat which fills in the space and holds these organs in position. The fat is also ornamental. Who would not prefer to look at a boy with plump cheeks, full arms and legs, and well-rounded body rather than upon one who is hollow-eyed and cheeked and lean of limb and body, in other words health is beautiful to look upon, and sickness or disease is unpleasant or pitiable. The fat is therefore a protection to the body in general, and to different organs which are supplied with it in particular. The apron of fat called the *omentum* which hangs from the stomach over the intestines protects them. You know what an enormous quantity of fat the sea animals, whales, walruses, and seals have, and though their blood is warm like yours and mine, and not cold like the blood of fishes, their thick layer of fat permits them to swim with comfort in ice water or to lie upon the surface of ice and enjoy themselves, for they probably would not sleep in such cold places unless they enjoyed it.



1. Liver. 2. Stomach. 3. Omentum.

THE IMPORTANT USES OF THE SKIN AND WHY IT SHOULD NOT BE NEGLECTED.

What an advantage the skin is as a *protection to the body.* What a finish it gives when it is *well-kept* *and clean.* Did you ever realize that you could not live without it? When large portions of it are burned or otherwise destroyed the person dies. We read stories of torture by Indians and other savages in skinning their prisoners. Perhaps you have read the ancient story of Marsyas who could play the lyre or harp so well that he challenged the god Apollo to play with him, and when he was beaten, Apollo, cruel god, skinned him as a punishment for daring to think he was as good a musician as the god of music.

We have told you of the different kinds of apparatus that were connected with the skin, the sweat glands for supplying the surface of the body with moisture, the hair which furnishes covering to the skin and is a protection from the cold when it is very thick, the sebaceous or oil glands which not only lubricate the hairs and prevent them from getting dry and brittle, but also furnish lubrication to the skin. Sometimes they furnish so much of such material and with such a bad odor that we wish the person who has it would move as far away from us as possible. One of the most important services which is rendered by the skin is that it is the means for disposing of the surplus or unnecessary heat which is made by the machinery within the body. Have you not sat or stood by people who seemed as hot as a furnace and by others who were as cold as a stone? If there were no such means of getting rid of or radiating the heat which is made within the body, the body would be quickly worn out, just as would happen to a furnace if it were continually supplied with fuel with no means of getting rid of the heat which was developed by it. Not only does the heat of the body pass off through the skin, but certain waste materials and impurities may also be disposed of in the same way. This is because the perspiration machinery which is distributed over the entire surface of the body is also abundantly supplied with blood vessels and lmyphatics. Certain drugs or medicines which are taken in at the mouth finally get into the blood and are passed out of the body, in part at least, through the perspiration apparatus. On the other hand the same apparatus permits us to introduce food into the body, and this is often of the greatest advantage when sickness prevents the use of the mouth and stomach for that purpose. Under the arms, in the thighs, in the groins, under the breasts the lymphatics and lymphatic glands are very abundant, and medicines, oils, foods, thoroughly rubbed into the skin in these places will quickly get into the blood and become a means for the treatment of disease, or for the nutrition of the body according to the substance that may have been used, and the completeness with which it has been absorbed. But the most important of all the uses of the skin is that it is the organ of sensation, or touch, or feeling. How quickly you respond if the skin is pinched or pricked. Sometimes a mere touch is sufficient to make you start and to give you a nervous shock like a shock of electricity. This sensitiveness is due to the fact that beneath the outer or horny layer of the skin are the millions of endings of the sensory nerves or nerves of sensation, and you know it would be difficult for you to put the point of a needle anywhere on the surface of the body where you would not feel it. You can judge from this how close together these nerve ends are.

Since the skin has all these important functions or uses you must see how important it is to keep it in good order. If it is very dry it should be moistened with some easily absorbed oil, like cocoanut oil, or lanolin which is obtained from sheeps wool. It should be frequently bathed in order that the myriads of glands with which it is provided may not be choked or clogged. I know that many people get along without bathing, and I do not say that everybody suffers who does not bathe, but the advantages which come with bathing are so great, and the pleasure and comfort which it brings are so generally admitted that it would hardly be worth while to try and prove to you the benefits of bathing over not bathing. Every boy who has been in swimming on a hot summer day knows how pleasant and refreshing it is, and if he formed the habit of bathing every day, that is of washing his entire body, even if he didn't have more than a quart of water to wash in, he would probably add to his physical health and comfort, and might prolong his life.

THE WONDERFUL LININGS WHICH NATURE PROVIDES FOR THE HUMAN MACHINE.

If you care to turn back to the description which we gave you of the different cavities of the body you will see that, with very few exceptions, all the cavities large and small have a *lining membrane.* This covers the wall of the cavity as the plastering and paper cover the wall of a room, and one would be as incomplete as the other without this finish. Furthermore the membranous lining is continued as a covering for the organs which are in the cavity. Thus the peritonæum covers the organs in the pelvis and abdomen, the pleura covers the lungs, and the pericardium the heart. The membrane which lines the skull is an exception and there is no lining membrane in the spinal canal, nor in the cavities which contain the eyes. Instead of having a lining membrane these cavities are supplied with fat or some similar material. Why should nature provide these membranous linings? The first object is probably protection. These cavities might have been left unfinished, perhaps the organs within them could get along with the lining of muscles and ligaments and other tissues with which they are provided. But the method of nature in making this human machine always seems to be to make the wear and use of the organs as easy and free from friction as possible.

In the cavity of the chest, for example, when the lung expands with air and fills its pleural cavity it does not rub against the bones or even the muscles which form the walls of the cavity, but against the same kind of a membrane as that which forms its own covering. Furthermore these membranes are not dry like parchment, but in all cases secrete a fluid which not only serves to keep them moist but also to keep them smooth and slippery. When the expanded lung rubs against the wall of its cavity therefore, it not only meets a protecting membrane but one which is also smooth, moist, and slippery. This, of course, lessens the friction, like oil upon the bearings of machinery and keeps the parts in good working order. Suppose the membranes were not supplied with this fluid, what would happen? In the lung the delicate cells which form the outer covering of the membrane would be bruised or destroyed and it is very probable that the disease which is known as pleurisy would result. The membranes which line the various cavities must therefore be in good working order or the organs which they are designed to protect will suffer injury.

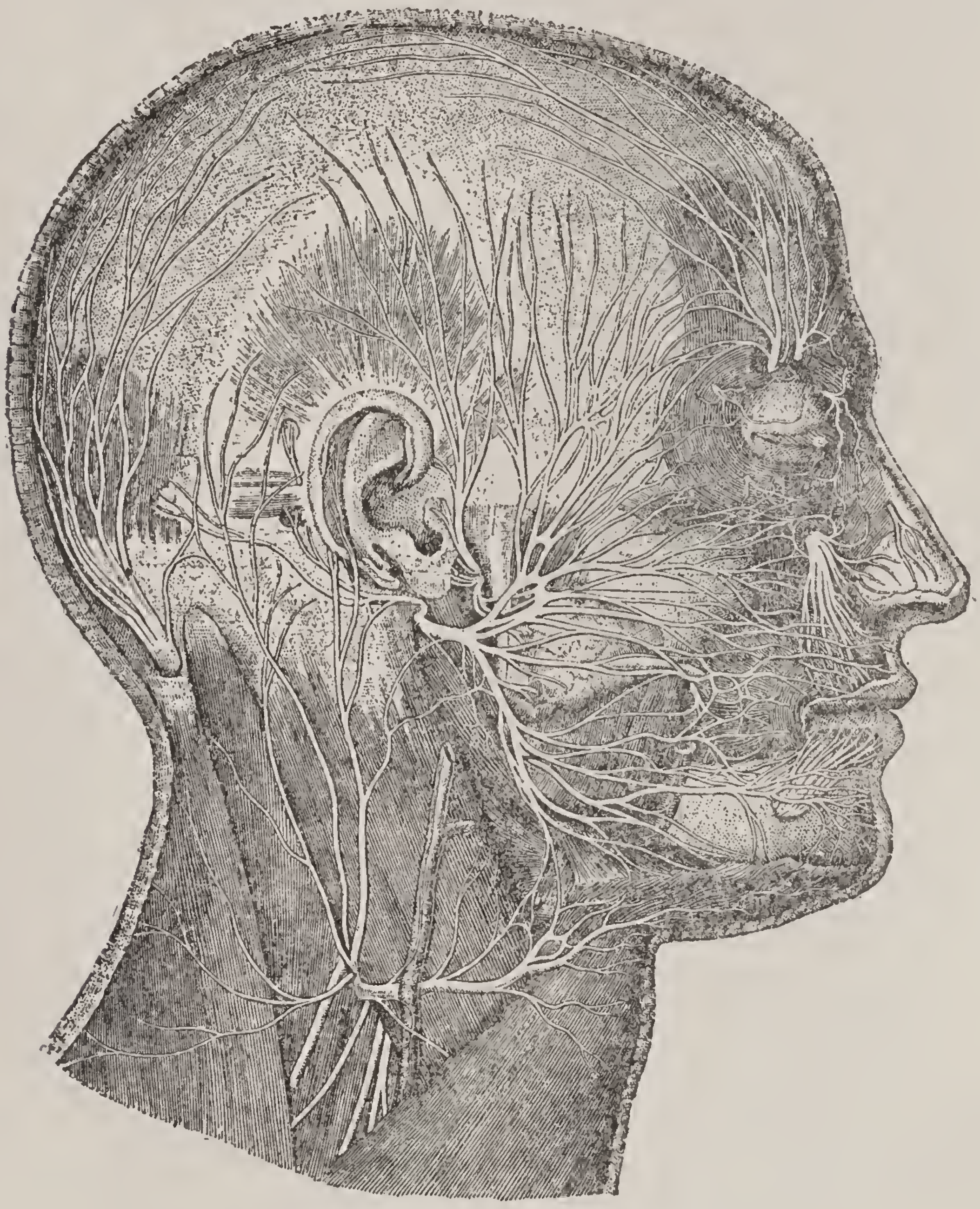
CHAPTER XI.

Some Things in the Human Building Which are Intended to Perform the Most Delicate, Useful and Wonderful Service.

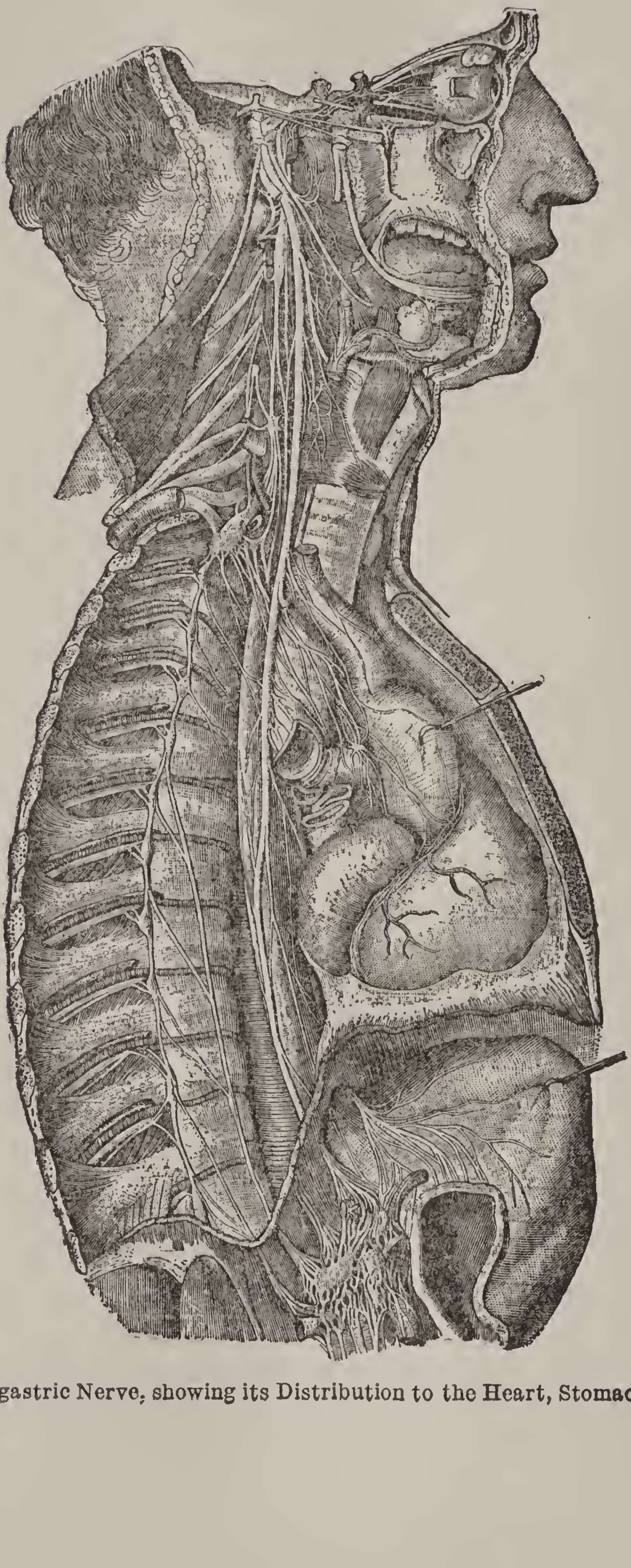
LOTS of people know they have "nerves," "blood vessels," and "glands," but the doctor is often astonished to learn how little many people really know about these things—even those who are in general may be very intelligent. But we must not blame them too severely for they probably never had a chance when they were young of reading about these important things in a work like The Foundation Library.

THE NERVES THAT ALWAYS WORK AND WORK WONDERS.

You will remember that there are three varieties or classes of nerves, (1) those which come from the brain, (2) those which come from the spinal cord and (3) those which are called the sympathetic nerves which go to the various organs within the body and are also connected with the spinal cord, and through the spinal cord with the brain. What do these various nerves have to do, what is their work? First let us consider those which originate in the brain; there are twelve pair of them going to either side of the body. Three of them are called nerves of special sense; they do not respond to the touch as do the nerves of sensation in the skin, nor do they control motion as do those which go to the muscles. They are occupied solely and entirely in bringing to the brain particular impressions which are brought by no other nerves. One of them brings impressions of light which the brain translates into what we call sight or vision; another impressions of hearing, and the third impressions of smell. Three pair of the remaining nine are distributed to the muscles of the eyes, to give them motion in various directions and thus produce the varying expressions which make the eyes such an important feature in the countenance. Another pair goes to the muscles of the face and, with a branch from another nerve, permits motion in those muscles, while sensation or feeling in all these portions is supplied by one large pair, with three divisions in each of its two nerves. Another furnishes motion to the muscles of the tongue, another sensation to the same and to muscles of the throat.



Nerves of the Head, Face and Neck.



Pneumogastric Nerve, showing its Distribution to the Heart, Stomach, Etc.

Of the last two pair, one furnishes motion to certain muscles in the neck and back and to the muscles of the larynx, which is the organ by which the voice or vocal sounds are controlled, while the other which is one of the most important nerves in the body, and is called the pneumo-gastric, assists in controlling the motion of the larynx, and goes to every portion of the lungs and controls their motion in the act of breathing. It also goes to the gullet by which the food is conveyed from the mouth to the stomach, and controls both its

Nerves on the Side and Back of the Leg.

sensation and its motion. Furthermore it goes to the stomach and likewise controls its sensation and motion and finally it sends branches to the liver to communicate with the sympathetic nerve supply of that organ. Of the spinal nerves there are thirty-one pair proceeding from either side of the spinal cord, each provided with an anterior or motion root, and a posterior, or sensation root, each nerve containing fibers for motion and others for sensation, the motion fibers going to the muscles, and the sensation fibers to the skin. The fibers which go to the skin take impressions or messages and bear them through the spinal cord to the brain. From the brain they are sent back to the muscles along the cord and the motion fibers, and produce motion.

The sympathetic nerves consist of lumps or ganglia of nerve tissue, arranged in two rows, one on each side of the spinal column. They are connected with each other by strands or strings of nerve tissue, and with the spinal cord by nerves of motion and sensation. They also send fibers to the organs and great blood vessels in the interior of the body, and in these locations form connections with other ganglia which control the nutrition of those organs and blood vessels. We may appropriately compare this complicated system of nerves with the telegraph wires which carry messages from one portion of the country to another, and which receive other messages in return from the different stations to which the messages have been carried. Or we may use the comparison of the steel frame building which is fitted with wires in every room and hall and closet for supplying light, and perhaps heat and power as well. The principal work which the nerves of the brain and spinal cord have to perform, therefore, is to *take the messages which come from the world which is outside of each individual, carry them to the headquarters, and take back, when necessary, other messages which the muscles will convert into motion.*

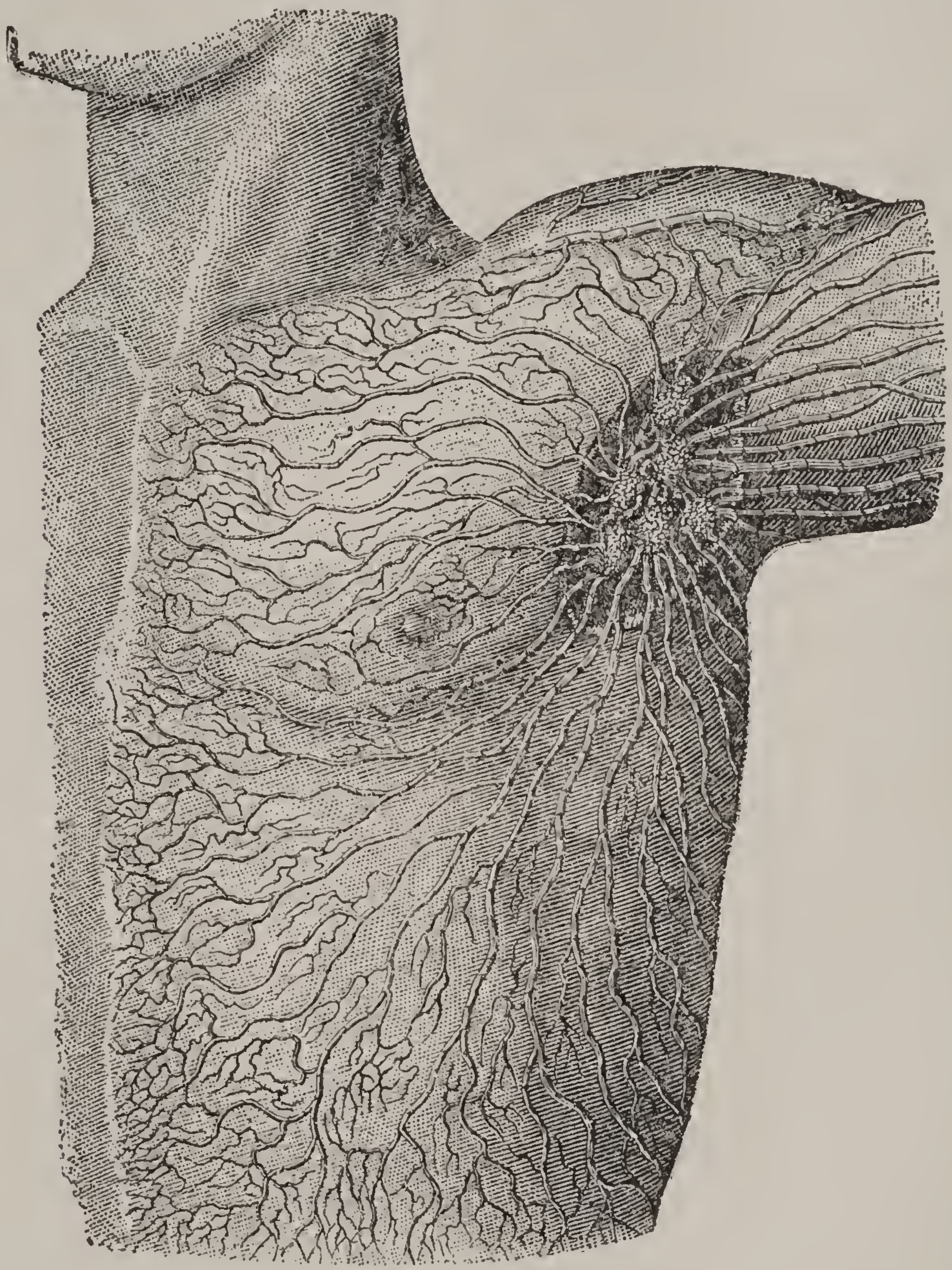
We seldom stop to think that what we call our senses of touch, taste, smelling, seeing, and hearing are dependent upon the condition of a few little nerve cords. The sense of touch is indeed distributed over the entire body, but it is possible by certain injuries to the brain or cord to abolish that sense entirely, in fact it is not at all unusual that people should be entirely helpless, unable to move hand or foot, unable to feel anything; you may prick them or cut them and they know nothing about it. We say that such persons are paralyzed, and very pitiable is their condition, for they may be able to live and breathe, and eat and sleep, but may never again be able to feel or to move. So also by cutting the nerves which go to the tongue, the eye, the ear, the nose, we may abolish one or all the senses, though the person thus afflicted may continue to live. You have doubtless seen persons who have been deprived of one or more of their senses; the blind and the deaf are always with us.

One of the important duties of the sympathetic nerves is to control the quantity of blood in the blood vessels. Certain influences may cause them to contract or squeeze the blood vessels of a certain part; the result will be that the blood will rush to other parts where there is less pressure. Again certain influences may cause these nerves to relax their hold on certain blood vessels, whereupon the blood will rush in, fill out the vessels and redden the surrounding tissues. For example a person is suddenly frightened, from one cause or another, and he becomes very pale. This means that the blood vessels in his skin have been suddenly contracted or pinched by the sympathetic nerves which are in their wall, and the blood is forced to find other channels in the interior of the body where the pressure is less. Again an impression of anger comes to a person and his skin at once becomes a fiery red, which means that the sympathetic nerves have suddenly relaxed their hold of the vessels in the skin and the blood has rushed into them with more than its usual volume. Sometimes the force of this current is so great that one or more of the blood vessels burst and there is a more or less abundant hæmorrhage. The nerves have a great deal to do with the work of the organs or machines within the body. Suppose the branch of the pneumo-gastric nerve which goes to the stomach were cut or seriously injured, the whole machinery of digestion would stop at once. The stomach could no longer move its contents back and forth, and the gastric juice would not be secreted. Or suppose the branch of the pneumo-gastric which goes to the lungs were divided; the lungs could no longer expand and the person would quickly die from suffocation.

The life and health of different parts of the body are dependent upon the presence and activity of the nerves which go to them just as much as they are upon the blood which flows through them. Cut off the blood supply and the affected part will wither and die. Cut off the nerve supply and the result will be the same. Sometimes it happens that a nerve is divided and either grows together after a time, or the surgeon may cut down, find the divided ends, and tie them together. This has even been done when the spinal cord was divided. While a nerve remains divided, and connection with the spinal cord and the brain is cut off there will be paralysis both of motion and feeling in the parts which are below or beyond the line of division, but as the parts of the nerve grow together and connection is reestablished, feeling and motion gradually return and with them comes new life into the part which may have been partially withered and useless. Sometimes when the nerve supply of a part seems to be out of order we can help matters by the application of electricity to it. When the faradic current is applied to such a part it will cause the muscles to contract, if they are not actually dead, and a judicious practice of such treatment is often very beneficial. Both the galvanic and the faradic currents are much used in the treatment of disease of the nerves, and from its good results in some cases it makes one think that there may be truth in the opinion of those who think that the force which circulates through the various parts of the nervous system is akin to if it is not exactly the same as the electric current. It must now be evident to you from what has been said that the nervous system is a most important part of the human machine and that the person who is wise, be he old or young will do his best to keep it in good condition, not abusing it by overwork, not neglecting it when it requires rest or medical attention.

LITTLE VESSELS WHICH DO A BIG BUSINESS.

The purpose of the little vessels called *Lymphatics* is very little known by people in general, in fact there are many people who have never even heard of them. They certainly have not seen them for those which are near the surface of the body are too small to be seen with the naked eye under ordinary conditions. And yet these vessels are distributed over the entire body and collect daily a quantity of fluid which is estimated at four pints, which is added to the blood stream. You can readily understand that a system of vessels which makes such a contribution as this, every day, to the blood is not unimportant. They are really a portion of the same system as the blood vessels, and whereas the blood vessels, especially the tiny capillaries, permit the blood to ooze out from them into every portion of the body, for the capillaries are almost everywhere and nourish the cells of which the different tissues are composed, the lymphatics which are also in almost every part of the body, absorb or suck up the fluid which the cells have not used, which fluid, in addition to the elements of the blood which it contains, contains also waste or worn out material which the cells no longer need. This waste matter is in a fluid condition, being melted or dissolved by the fluid by which it is surrounded. In the fluid which is absorbed by the lymphatics you will remember that it is not usual to find the red corpuscles of the blood but we do find plenty of the white corpuscles, together with the fluid portion of the blood or plasma. If this matter should not be quite clear to you imagine first that there is so much pressure of the blood current in the capillaries that the blood oozes through their thin and not very tight walls. The tissue into which it oozes is not hard and dense like iron but more or less porous. The cells



Lymphatics and Lymphatic Glands on the Left Side of the Body and Shoulder.

in this porous tissue take what they require of the fluid which has oozed out. This fluid has a kind of current which sets toward the lymphatic vessels and having reached them it soaks through their delicate walls, and joins the current which is moving toward the blood stream again. You may not understand how the fluid gets into these lymphatic vessels but please remember that it is not necessary that there should be holes in them to allow it to pass through. In accordance with a principle which is known as *osmosis* if there are fluids of different densities or heaviness on the two sides of an animal membrane or tissue, the lighter one will pass through to join the heavier even though there are no visible openings in the membrane. Perhaps that will explain the passage of fluids from the tissues through the wall or membrane of the lymphatic vessels to the lymphatic current. The lymphatics therefore act the part of waste-pipes, and the waste material which they pour into the blood is removed from the body by the kidneys which carry it out with the urine, by the lungs which remove it in the form of carbonic acid, and watery vapor which we exhale in out-breathing, and by the skin in the insensible perspiration which is constantly passing off.

MILLIONS OF BUSY LITTLE STRUCTURES.

But in addition to the waste material the lymphatics also carry food material which they obtain from the millions of little structures which are scattered over the mucous membrane of the small intestine and are called *villi.* The food material which is absorbed through these *villi* is called *chyle,* that portion of it which is absorbed by the lymphatics of the *villi* being really an emulsion of fat.

It is estimated that there are from fifteen to twenty millions of these villi distributed like an army of little cones from one end of the small intestine to the other. As they play so important a part in the work of absorption of the liquid food of the body you ought to know how they are constructed. Imagine then a very minute cone, its outer portion made up of a layer of cells placed side by side. A small artery enters its interior at its base, at one side, going from bottom to top, and a small vein leaves it on the opposite side, going from top to bottom. Between the artery and the vein is a mesh of capillaries. Passing up also into the middle of each one of these little cones, in the midst of the mesh of capillaries is a little lymphatic tube which because of the milky emulsion of fat which it takes from the chyle is called a lacteal. The blood vessels in the *villi* absorb a portion of the entire stream of chyle or digested food which flows by them in the intestine, while the lacteals which belong to the lymphatic system absorb only the emulsioned fat which they pick out, as it were, from the stream. Now if there are fifteen million of these *villi* and each one of them is working during the hours of digestion you can imagine what busy times there are in your body with the digestion of each meal.

We said you could not see the small lymphatics of the skin, but if you should be unfortunate enough to get the disease which is called septicæmia, or blood poisoning, you might be able to see them. Suppose for example, you received poisonous germs into a wound in your finger, a mere scratch or slight cut it may be, such as surgeons frequently get in the performance of their work. These germs are taken up by the nearest lymphatics, they multiply with amazing rapidity in the lymphatic current, and soon spread through more or less of the body, producing the pain, the fever, and the other well-known symptoms of blood poisoning. They travel from the finger up the lymphatics of the hand and arm and soon you may discover a brilliant red line perhaps extending the whole length of the arm which is painful and accompanied with more or less swelling. The red line with its branches marks the course of the lymphatics which have become diseased and inflamed and is a proof that lymphatics are really there, though under ordinary conditions you could not see them. Thus, to repeat what has already been said, the lymphatics not only bear away the waste materials of the body, not only carry to the blood certain portions of the food, but they also carry poisons and may be injured by them, in addition to the injury which may come to the body in general.

THE "COLLECTING AND DISTRIBUTING AGENTS" OF THE BODY.

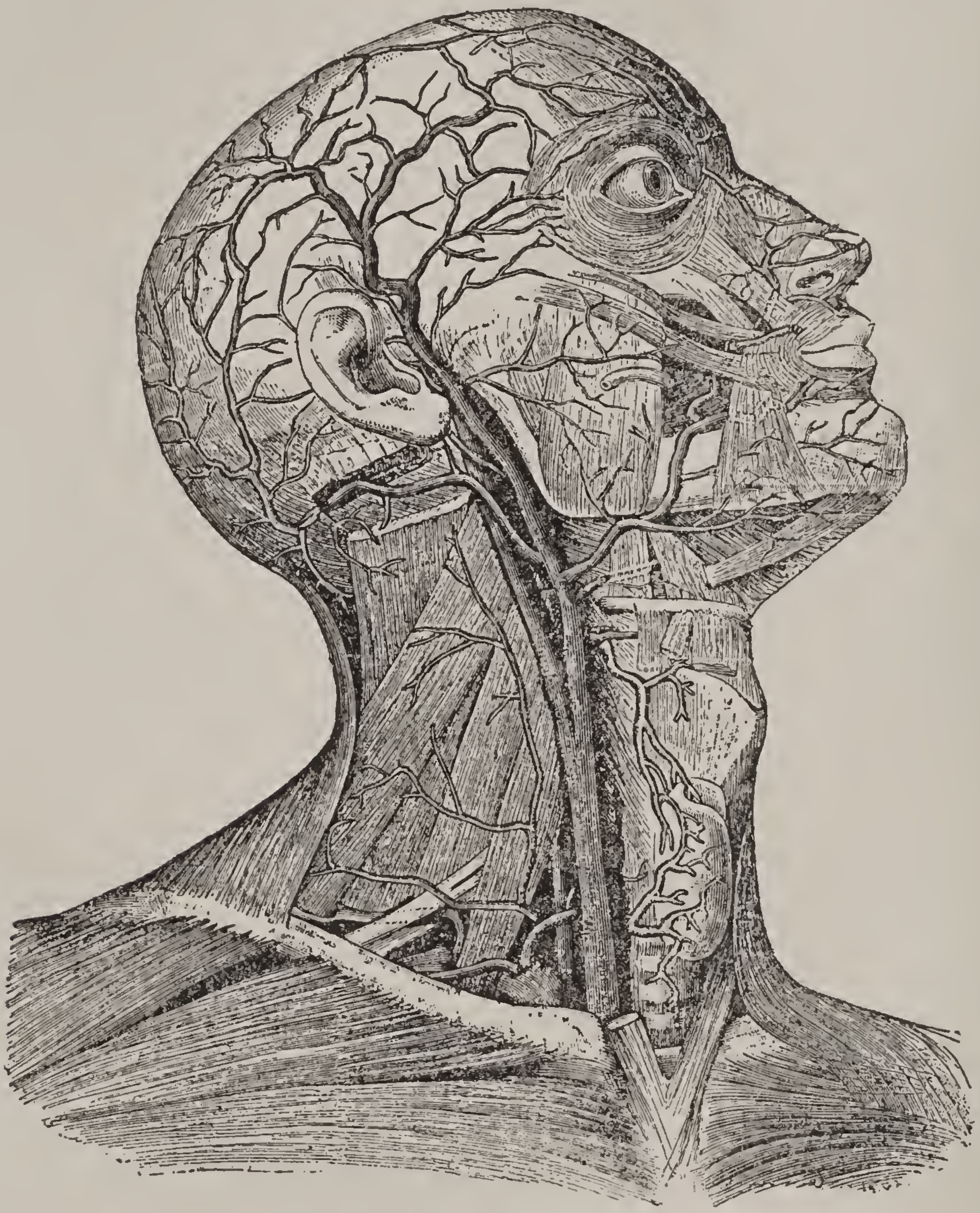
We have told you that the blood vessels were of three kinds, arteries, capillaries, and veins, and I have also just told you that the lymphatics were vessels which were connected with the system of blood vessels and in one sense, were a part of that system, for their current always sets toward the veins, though the fluid which they contain is not blood, but one which is to be poured into and mixed with the blood.

WHAT THE ARTERIES DO.

The arteries contain purified blood, that is blood which in its passage through the lungs, and kidneys and skin has gotten rid of various impurities which it contained, blood which has absorbed, in the lungs, the oxygen which has been taken into them in the air which has been inhaled, each time that a breath has been taken. They also contain the fluid food which, with the oxygen, is to be distributed to the cells of the entire body, and they sometimes contain poisons which, if they cannot be expelled, will produce serious and perhaps fatal mischief.

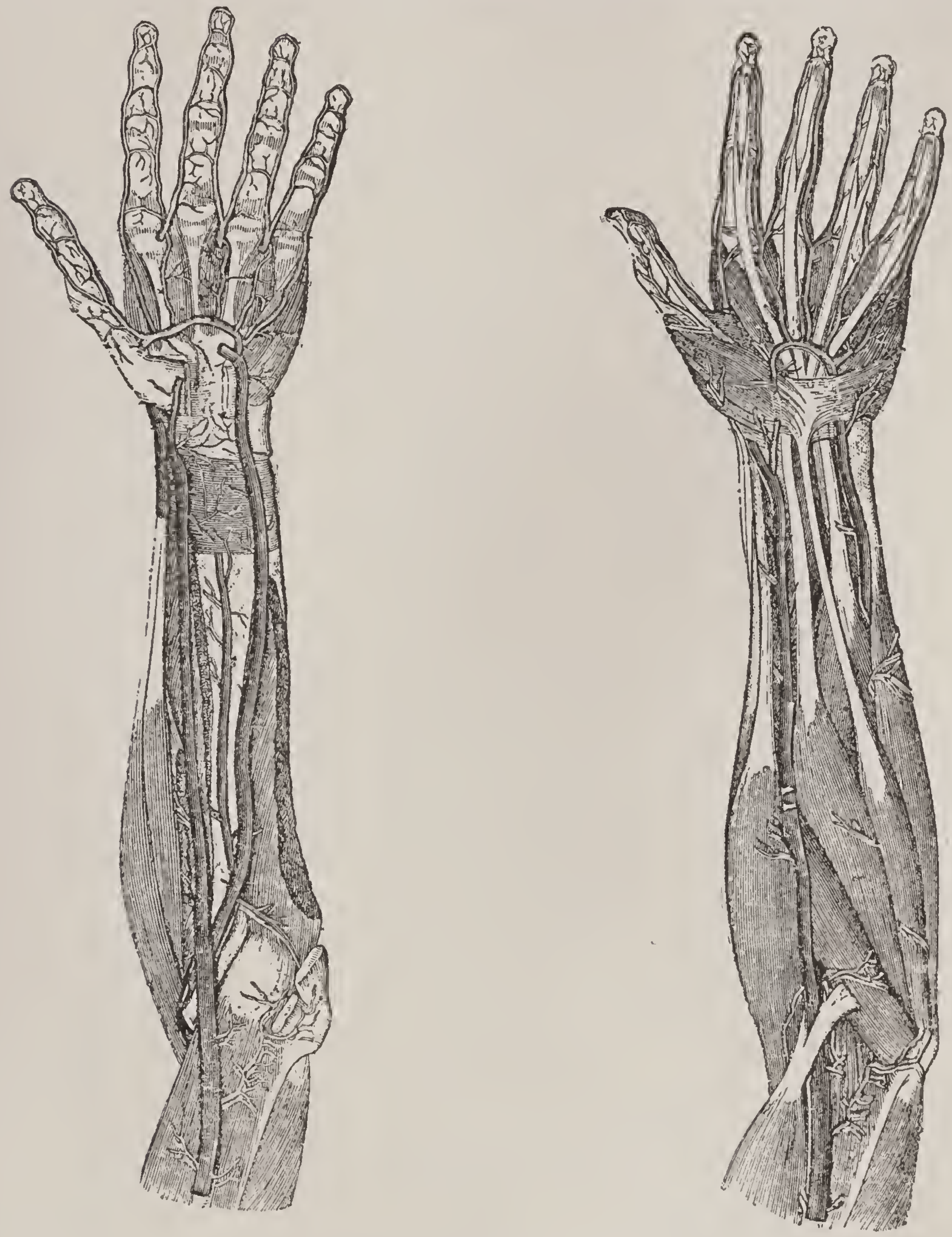
LITTLE STRUCTURES WHICH ARE ALWAYS AS "BUSY AS BEES."

The capillaries receive the blood from the arteries and distribute it to the cells of the tissues. They form a great network or mesh throughout the body, with the arteries on one side and the veins on the other. The work which they have to do is the constructive work, the building-up work of the body. They are the structures to which the cells look, as it were, for the materials with which to perform their work, and you must remember that it is the cells of which every part of the body is composed that do the business of the body. The cells are like bees or ants, each of them very small, but each of them with a particular task to perform which, in the total, makes the output of work of the



Arteries of the Neck and Head.

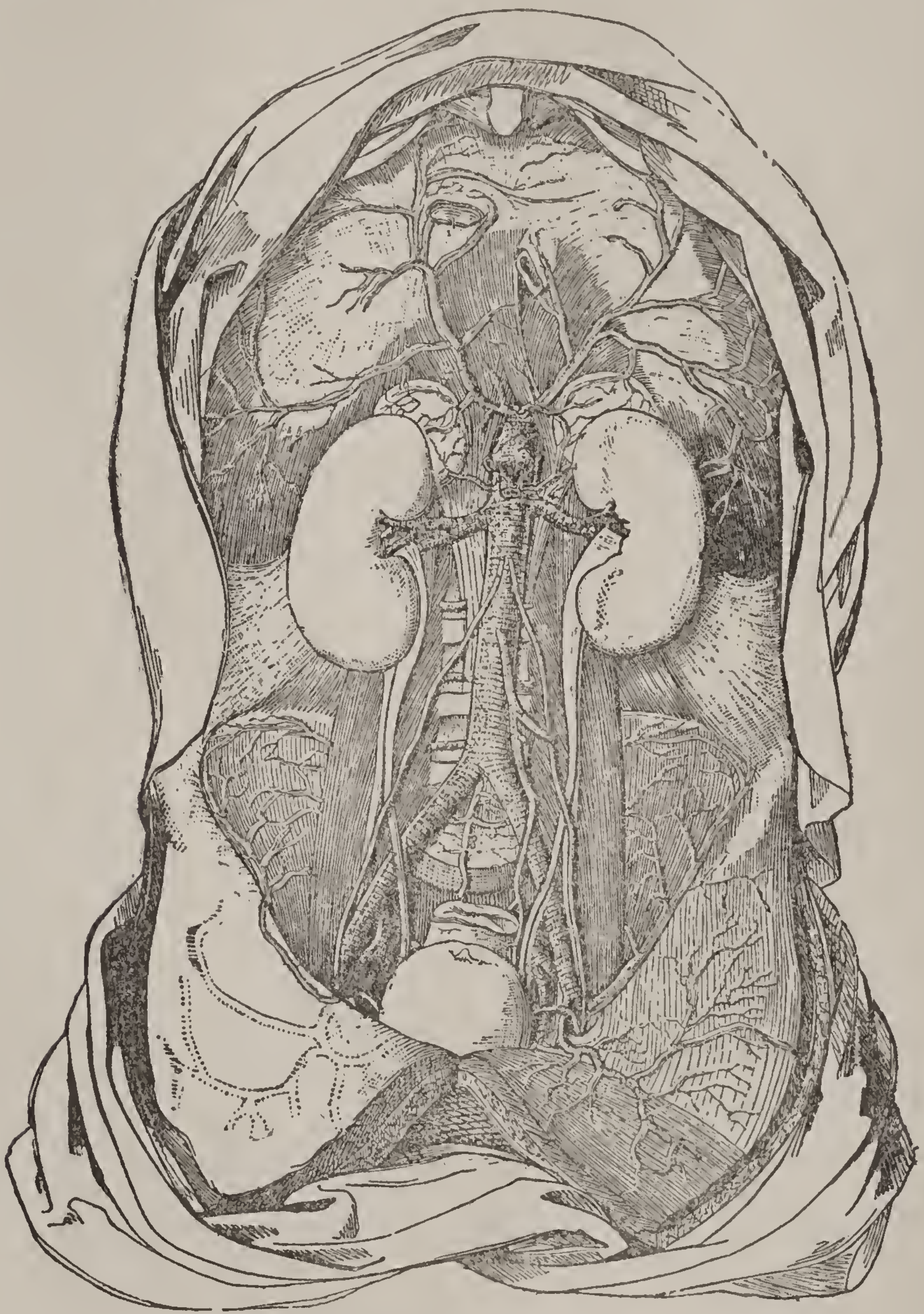
body, and they could not do this work unless the capillaries brought them the material to do it with. Listen to the story of the work which the capillaries have to



Arteries in the Arm and Hand.

do: they give the food material—the albumen, the fat, the sugar, the mineral substances—to the cells in general; in the various glandular organs—the stomach, the pancreas, etc.,—they supply the cells with the substances by means of which they make their secretions;

in the *villi* of the intestines, in conjunction with the lymphatics, they gather in the digested food, distributing it, in this instance, to the veins and not to the cells; in the kidneys they give up the poisons and other materials which go into the urine; in the lungs, reversing the usual process of which we shall tell you by and by, they receive the impure blood which has traveled over the body, discharge the poisonous carbonic acid which it contains, take up the life-giving oxygen, and send

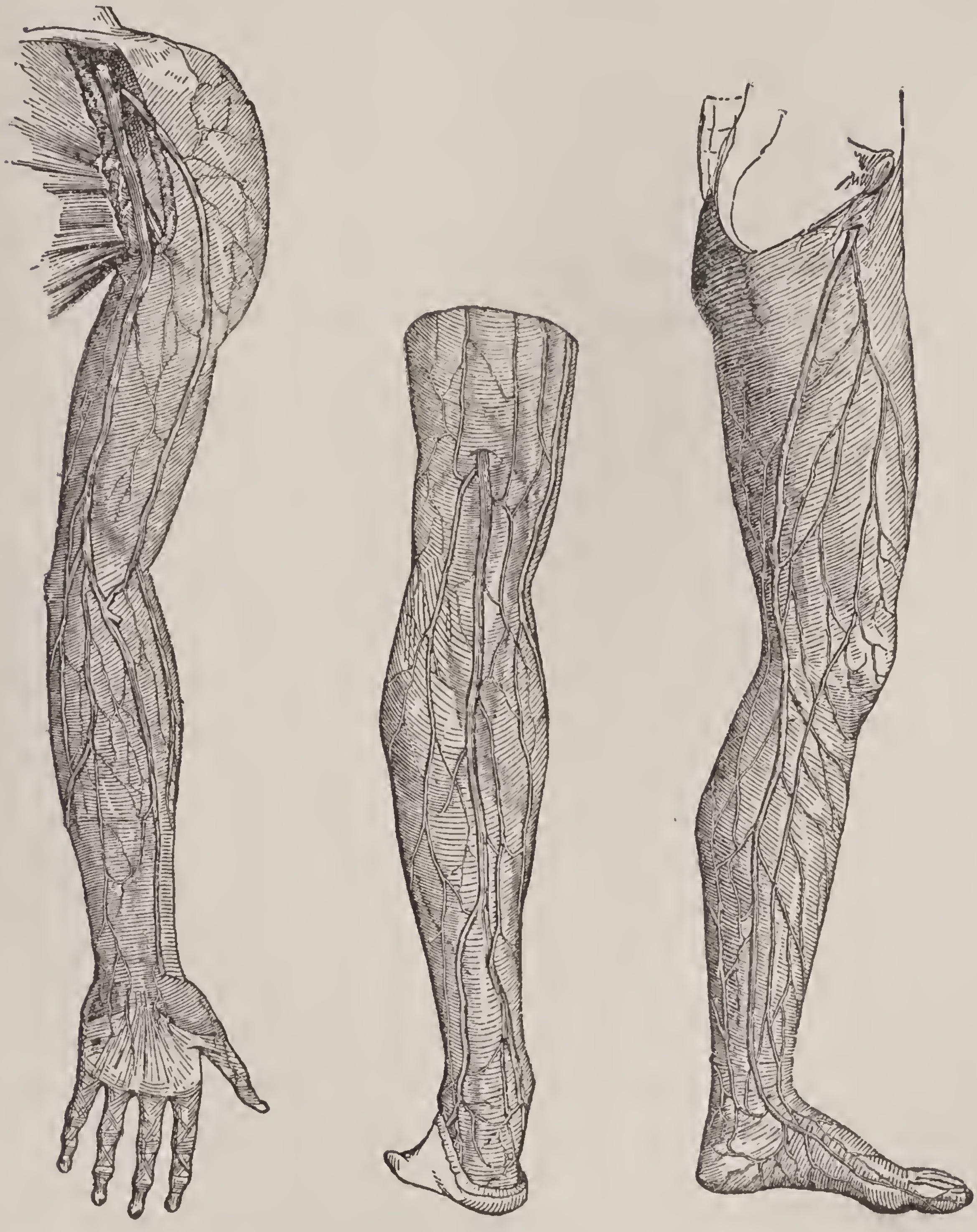


Plan of Development of the Arteries from the Trunk or Abdominal Aorta; also the Kidneys, Ureters and Bladder.

it, thus purified, on its way back to the heart to go over the body again through the arteries.

WHAT THE VEINS DO.

The veins collect the blood which has performed its work through the arteries and capillaries. It now contains impurities, and unless these can be removed life cannot continue. Its very color has changed since it began to flow from the capillaries toward the heart.



Veins of the Leg and Arm.

When it left the heart to traverse the body it was a bright scarlet, now it is purple or dark red. The two great veins of the body (vena cava superior, and vena cava inferior) having collected it from all the tributaries, like two great rivers, empty it into the right upper chamber of the heart whence it flows into the right lower chamber to be pumped from this reservoir into the lungs where it gives up its poisonous ingredients and comes back to the heart purified and ready to go on its journey over the body again through the arteries.

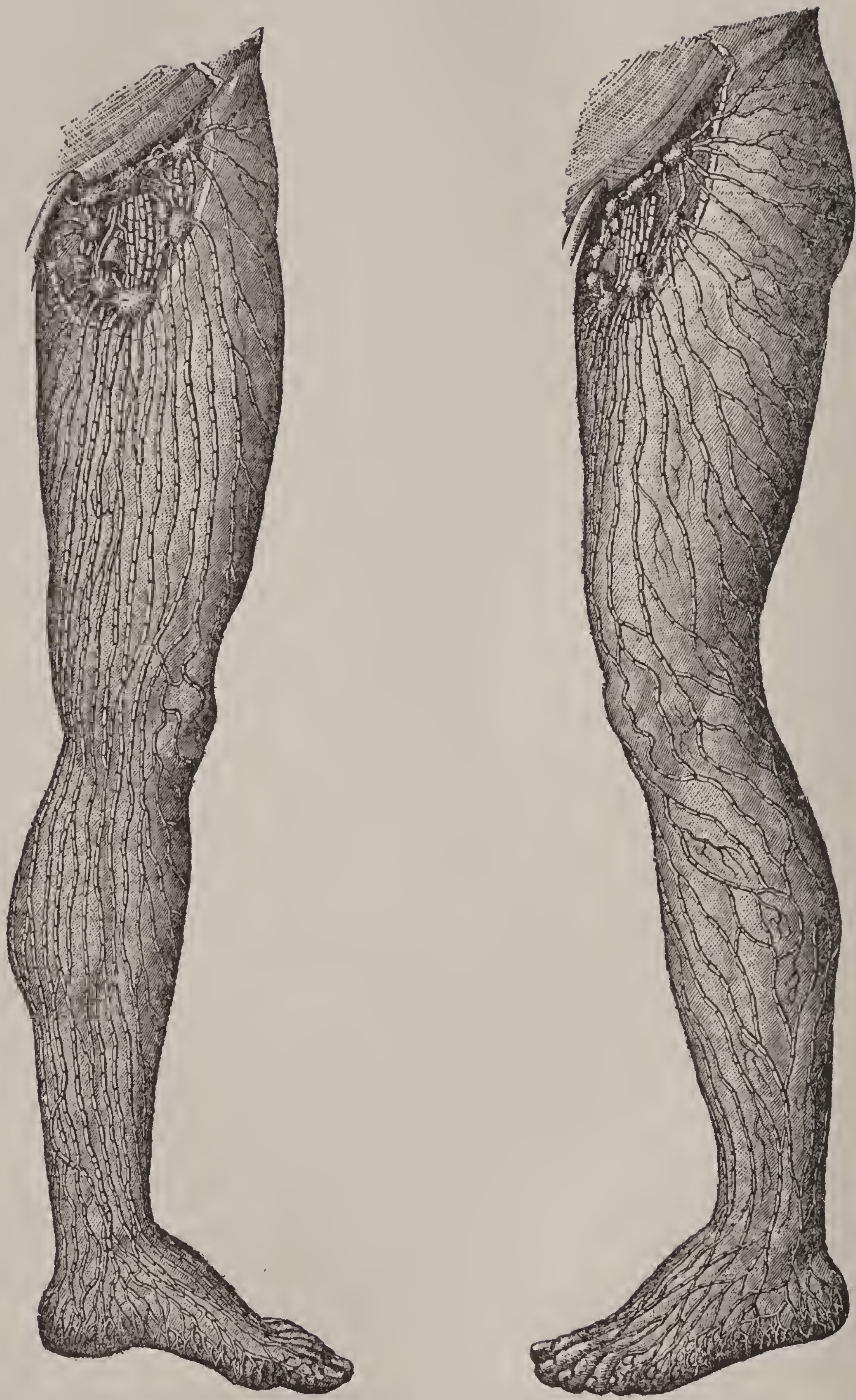
THE EXPRESS COMPANY OF THE BODY.

Now what can we compare this system of vessels with more appropriately than an express company. Such a company receives packages at its office, it ships them upon the railroad train which delivers them at the various stations to which they are directed, and it takes other packages, to be sent in their turn, back to the central office, there to be disposed of in the proper manner. In carrying the different substances which are in the blood, the blood vessels are therefore carrying life to the body. The body could not live without these substances, and as we saw in the chapter about blood, if you should open one of the vessels of the body and draw off too much of this fluid you would, at the same time draw off the person's life. If you were to draw off a pint from a grown person he would feel dizzy and would probably faint, and if you were to draw off two or three times that quantity he would die. As you probably know, a great many people give up their lives in that way, in war, in fights, in accidents, and in diseases of various kinds.

Another important work which the blood vessels have to perform, in carrying the blood to the different portions of the body, is to give the body the heat which is necessary to life. No living thing, whether animal or plant, can get along without heat. The plants do not grow in winter, nor in the arctic regions where there is always snow and ice. The heat must also be within the body of the animal or plant, for unless it is, it matters not how much heat may be without, in other words it matters not how hot the weather may be, life will not continue. On the other hand the weather may be very cold, but if the body has within it a sufficient amount of heat, life will continue. Each variety of animal has its own particular requirement of heat, which we call the temperature of its body; a fish requires less heat than a human being, and a human being less than a bird, and this heat is largely regulated by the blood supply. You can prove this by tying a tape around your finger and if you do it in such a way as to force the blood out of your finger you will very quickly notice that the finger is cold. When your fingers and toes are cold in winter it is because the blood is not flowing freely in them, and you may have noticed that the body of a dead animal feels very differently from a living one in which the blood flows freely. If, therefore, any portion of your body feels cold you may depend upon it that it has not enough blood in it, or else that there is something the matter with the quality or condition of the blood or of the blood vessels. Sometimes the blood vessels get diseased and hard as pipe stems, so that you could break them as you would a pipe stem. When this takes place, and it happens quite frequently in old people, the blood cannot be distributed to the cells, as it is when one is in health, and the part which is thus diseased gets cold and dies. Such a condition most frequently attacks the feet before it attacks other parts of the body, and it may be necessary to cut off the feet in our endeavor to save life.

OTHER INTERESTING STRUCTURES OF THE BODY AND THE WORK THEY DO.

You will remember that we told you that a gland was a structure or machine, large or small, within the



Lymphatics and Lymphatic Glands in the Skin.

body, which took from the blood materials for which the body had no further use and which were to be put out of it, or it might be a machine which took out certain materials and then changed them into a product which was called its secretion, and for which the body had further use. We are going to consider now only the latter variety of glands. A gland may consist of only a single cell, like a cell in the mucous membrane, which secretes or manufactures one drop of mucus at a time, or it may be the largest organ in the body, the liver, which contains many millions of cells which are working with great industry, most of the time, making bile. In addition to the liver which makes bile and the mucous glands which make mucus (and there are several varieties of these glands in addition to those which have but a single cell), what are the glands of the body, and what are they for?

First we may mention the lymphatic glands which, as we saw, were the reservoirs or pouches connected with the lymphatic vessels; both those vessels which are in the skin and those which lie more deeply within the body. Some of them look like beads and others like good-sized beans, especially when enlarged by disease. The lymph current flows through them, and may be stored up in them if necessary, but it is also believed that they manufacture the white cells which form a portion of the substance of the blood. The lachrymal glands manufacture the tears. Then comes the group of glands which take part in the digestion of the food including the salivary glands of the mouth which make saliva and ptyaline, the mucous glands of the mouth and tongue which make mucus, the glands of the stomach which make gastric juice, the pancreas which makes pancreatic juice, the liver which makes bile, the intestinal glands which make weak digestive fluid and mucus. The mammary glands which make milk are also important in connection with the process of digestion. The group of glands in the skin, in addition to the lymphatics, is also interesting, and includes the hair, the sweat, and the sebaceous or grease glands.

The mucous and serous membranes in the different cavities of the body all have their glandular apparatus, some of which is simple and some complicated, but all are busy doing their work and making their secretions. All of these glands together with a great many others which we will not mention, because it would complicate the subject too much and take you more deeply into the study of anatomy than you are as yet prepared to go, make their secretions and discharge them, either through a duct or tube, or directly upon the surface with which the gland may be connected. There are also other glands which manufacture a secretion but have no duct or tube through which it can pass and consequently tell us very little about their work or purpose in the body. The influence or object of the secretion of such glands is therefore more or less a matter of guesswork. The spleen is an example of this kind of glands, and it is believed that it makes white blood cells like the lymphatic glands.

Glands which have no duct are probably of great importance, for when they are diseased, and are removed on that account, the result is frequently a fatal one. Their work and their purpose in the body are therefore subjects which are yet to be explained by those who pursue the study of anatomy and physiology as a business. When one thinks of this wonderful glandular apparatus which is distributed so richly over the whole body, of the great number of laboratories and storage reservoirs which it signifies, and the great number of substances it is constantly producing as long as life continues, it fills one with amazement at the complexity of the human machine.

CHAPTER XII.

The Machinery of the Body.

THE ORGANS WHICH FEED THE BODY.

THE abdominal organs, or the machines in the abdominal cavity or belly, are the ones which are especially devoted to the nutrition or feeding of the body. The abdominal cavity is the place where the heat or energy of the body is developed. On another page we called it the engine room, where the furnace is located. Not all the organs in the abdominal cavity, however, are intended for carrying on the nutrition of the body. The kidneys, for example, are for another purpose, and will be considered by and by. The spleen is an organ which may or may not be connected with digestion or nutrition. Only a few paragraphs back we told you it was one of those organs which have no duct or tube to let out the material which it manufactures or secretes. It is believed that it is one of the organs which make the white blood cells, like the lymphatic glands, and as it is also somewhat similar in structure to the lymphatic glands I am inclined, personally, to think that it belongs to the lymphatic system. But if that is so you may ask why it is placed in the abdominal cavity, side by side with the digestive organs. You might also ask why the kidneys were placed in the abdominal cavity. Perhaps we might answer in a general way that the kidneys were located as they are because it was most convenient to locate them there, and that the spleen was so placed because there doesn't seem to be any other location for it, all the spaces being occupied, like the berths in a sleeping car. There are some who believe that it is connected with the change by which food is converted into tissue, and there are some who recommend an extract which is made from it as a cure for indigestion and various other diseases. You are at liberty to believe these statements, or not, as you choose. That it is a very important organ appears, from the fact that its removal by the surgeons, when it is diseased, is very often fatal, and that in such diseases as syphilis, typhoid fever, and malarial fever it is one of the organs which almost always is the seat of great disturbance.

HOW THE FOOD WE EAT IS DIGESTED BY THE STOMACH.

With the exception of the spleen and the kidneys all the abdominal organs are connected with the functions of digestion and absorption. Digestion means, first, the reception of food into the mouth, then its mastication or chewing by the teeth, its moistening and softening by the saliva and mucus, after which it is grasped by the swallowing muscles, squeezed down the gullet and dropped into the pouch at the left end or extremity of the stomach. After the stomach has received it two things happen, first the glands in the mucous membrane, or inner coat at once begin to shed or pour out mucus and gastric juice, which mingle with the albuminous parts of the softened and pulpy food, meat, fish, eggs, etc., and continue the softening and dissolving process, and second the stomach itself begins to move, not out of the body, but by the shortening and lengthening of its muscular layer which is below the mucous layer. The digesting food excites it, as a rat excites a terrier; it squeezes and shakes it from one end to the other, and gradually empties it through the opening at its right extremity into the first part of the intestine. Some of the more thoroughly digested food may be absorbed or sucked up by the capillaries of the stomach, but in any case the quantity is small. The work of the stomach therefore is essentially the digestion of the albuminous food. The pancreas is similarly excited when the now partially dissolved food begins to pour into the small intestine; its cells begin to drip their juice and its duct or outlet tube pours it in a tiny stream upon the current of semifluid food. This juice does three things; it co-operates with the gastric juice in digesting the albuminoids which have escaped the action of that fluid, it digests and liquifies peas, beans, potatoes, and other starchy foods which the gastric juice has no power to attack, and it breaks up or emulsifies fat into such small particles that they can be taken up by the absorbent vessels, which cannot be done with fat in its ordinary form. The digestive work of the process, considering its small size, is more powerful than that of any other digestive organ.

The same conditions which excite the stomach and pancreas also excite that great organ the liver, and its cells get busy in making and pouring out bile. The little bile tubes filled with the juice from the liver empty into larger and larger ones and finally the stream is poured through one main tube into the small intestine, through an opening which is just above the opening of the pancreatic tube. Once in the intestine the bile helps the pancreatic juice to liquify the starches and fats, it dilutes the stream of fluid food, making it more fluid, and it stirs up the muscular fibers in the intestine, making them contract and squeeze the current of fluid food forward and downward. But the liver does something in addition to making bile, it makes and holds in storage a substance called glycogen or liver sugar. The way in which it is made is as follows; the blood which is collected in the myriad of small veins in the stomach, spleen, pancreas, and intestines is accumulated in four large veins which unite in one larger vessel called the portal vein; a multitude of brooks and rivulets, four small rivers, one main river. This blood contains the fluid substances which were absorbed from the small intestine after they had been digested and dissolved. One of these substances is glucose or grape sugar. The portal vein enters the liver and divides and subdivides until its finest branches pass around the little lobules of the liver where they further subdivide into the network of capillaries which surround the liver cells. Each of these cells has five or six sides and hence they do not fit closely together. In the infinitely small spaces between these cells some of the liquid glucose in the blood is deposited. During this process it loses a portion of the water which it contains, and by this change becomes more or less solid. This new substance which is glucose, minus water, is called glycogen. But it does not remain glycogen very long, for by the chemistry of this wonderful laboratory it is gradually changed to glucose again and carried away by the blood in the veins which go out of the liver, to be further changed or further used as the wants of the body may require. When the blood gets from the liver a larger quantity of glucose than can be used, the glucose appears in the urine and informs us that the individual is suffering with the disease which is called diabetes, of which you have been told in another place. Connected with the liver and attached upon its lower surface is the sac or bag called the gall-bladder which, as you know, holds the surplus bile which has been poured out by the liver, until it may be required. The liver, therefore, is for the manufacture of bile, and it has an annex or storehouse for a surplus which may not be immediately required; it is also for the manufacture and storage of glycogen or liver sugar, which is made from glucose or grape sugar, and is changed again into glucose. The small intestine receives the food which has been partly digested in the stomach, it also receives the current of bile and pancreatic juice which continue the work of digestion and it helps to finish this operation by furnishing a small quantity of digesting material, which is not very influential, by itself, but is more or less useful in concluding the work of changing starch into sugar and making an emulsion of fat. The intestinal juice being slippery and sticky is also useful in lubricating the surface along which the current of fluid or semi-fluid food must pass. This current is propelled along the twenty feet of track of the intestinal tube by the squeezing and shortening of the muscle fibers which form its middle coat. In a very thin person you can sometimes see these movements, like the wiggling of a worm as it moves over the ground. But the small intestine, which is the field where a large portion of the digestive work is performed, is also the field where the digested fluid is principally absorbed. Digestion would be of no use without absorption.

We saw on page 171 that fifteen or twenty millions of little cone-like structures called *villi* were distributed over the mucous membrane or inner coat of the small intestine and that within these cones were blood vessels and lymphatics. The digested fluid is absorbed by both of them, but the lymphatics or lacteals absorb only or chiefly the emulsioned fat. It is almost entirely absorbed, as a sponge absorbs water which may be flowing by it, when it reaches the large intestine. There now remains only a solid or semisolid residue for the large intestine to dispose of. The muscular fibers of the large intestine squeeze and shorten in the same manner as those of the small intestine and by this means force its contents along. The juice from the glands of the large intestine lubricates its surface and facilitates their progress. Finally they reach the rectum and are then ready to be expelled from the body at the proper time.

Let us now sum up the steps which the food takes, from beginning to end, in the digestive organs which form the mill or machinery for turning it into fuel for the use of the body. Food of all kinds is taken into the mouth, bitten off, if necessary, with the front and side teeth, then ground to a pulp by the back teeth. It is moistened by the saliva and mucus of the mouth and the digestion of starchy food begun by the action of the ptyaline in the saliva. The soft mass is then seized by the muscles which control the act of swallowing, hurled into the gullet, down which it is squeezed and dropped into the large pouch at its left extremity, like a log which is grasped in the swift current of a stream, hurled over a precipice and landed in a pool at the bottom. In the stomach the food is churned back and forth, mixed with gastric juice and mucus, and its albuminous ingredients more or less dissolved. When this treatment has been carried on sufficiently, it drops from the opening at the right extremity of the stomach into the small intestine. There it is immediately met by a current of bile and another of pancreatic juice, by which albuminous foods are further dissolved, starches changed to sugar, and fat changed to an emulsion. The work is then aided by the juice from the intestinal glands. Most of the food, by this time, is in a liquid form, and as it flows along the small intestine is sucked up by the blood vessels and lymphatics in the *villi.* The waste and undigested matter is carried through the large intestine and is expelled from the end of the rectum. Of the food which has been absorbed, that which is in the blood vessels goes by the proper veins to the liver where it undergoes changes and is then carried out to one of the great veins which empties into the right upper chamber of the heart. The food, which has been absorbed by the lymphatics, and which consists chiefly of fat in the form of emulsion, is poured by the great trunk vessel of the lymphatics (thoracic duct) into the great vein (sub-clavian), on the left side of the neck and is finally emptied into the right upper chamber of the heart through the second of the two great veins which end in that chamber. The albuminous food becomes the soluble albumen of the blood, the sugar is changed into glycogen in the liver, and again to glucose, after which it is more or less decomposed as the blood flows through the arteries and capillaries, while the fat is decomposed as the blood flows through the lungs. The mineral salts are in solution in the blood and undergo very little change. The blood thus enriched with all these necessary elements circulates in all portions of the body and supplies the cells with such food as each variety of cells may require.

THE SPECIAL WORK OF THE KIDNEYS AND THE BLADDER.

The kidneys, you will remember, are on either side of the backbone, halfway from bottom to top. The bladder lies in the front portion of the pelvis or basin, and is the storage reservoir for the urine which is filtered from the blood which passes through the kidneys. The links between the kidneys and the bladder are two long tubes called ureters which pass down either side of the backbone, cross the lower portion of the pelvis and enter the back and lower portion of the bladder on either side. The kidneys, ureters, bladder, and urethra, which is the tube through which the urine passes out of the body, together make what is called the urinary apparatus, that is the machinery by which the urine is prepared, stored and discharged from the body. You must not forget that the urine is a waste product. There is nothing which it contains, in its normal condition, which the body desires to keep for any length of time. Its principal ingredient aside from the water, namely urea, is a deadly poison, and if the kidneys are not in condition to remove it from the blood, and it accumulates in that fluid, the person will soon die unless it can be removed in some other way; for example by causing the person to sweat profusely. On the other hand, if the kidneys take from the blood what does not belong to the urine it is a danger signal, but not usually of so urgent a nature as when the urea is omitted from the urine. Thus the urine may contain albumen, sugar, blood, pus, and various other substances which do not belong in it and which tell us there is something wrong either in the kidneys themselves or in some other organ or part of the body.

The kidneys do not make any substance which can be used for the upbuilding of the body, their principal business is to take from the blood those substances which are no longer of any use to the body. They are like a sewer which carries off material which has done its work and must be thrown away. There is always work enough for both of them to do, but if one of them becomes so diseased that it is necessary to cut it out, the remaining one will sometimes perform double service, though we cannot believe that it will always do it as well as if there were two, otherwise we would have been supplied with only one. We must always remember, when portions of the body are removed, that it is impossible to improve upon the plan which nature has arranged. If circumstances should arise by which the plan of nature is thwarted we must try and find a way to relieve the difficulty and make the harm and mischief as little injurious as possible. Sometimes the condition of the blood which flows through the kidneys is such that stones are found in them. These are almost invariably a source of great pain and suffering and they may lead to the destruction of the kidney and even of life. Sometimes they are forced into the tube which leads to the bladder, and as this tube was not made for such purposes, it becomes a very painful and sometimes an impossible task to try and squeeze the stone down into the bladder. Even if it reaches the bladder it may increase in size and give additional trouble. Sometimes the formation of a stone will originate in the bladder, but whether it is in the bladder or in the kidney the person who possesses it is usually very miserable until it is taken out.

The kidneys and bladder are subject to many other diseases, but the skill and knowledge of surgeons nowadays are such that they are often cured or at any rate greatly relieved. One of the common habits of people, both young and old, consists in not responding to the call of nature to empty the bladder when it contains a sufficient quantity of urine. The results of this habit are sometimes very bad. The muscular coat of the bladder may at length become more or less paralyzed and it will not contract properly and force the urine out even when there is a desire to do so. When this occurs some of the urine still remains in the bladder and that organ is consequently never thoroughly emptied. The urine which remains becomes decomposed, the mucous membrane of the bladder becomes inflamed, and a certain amount of poisoning may take place from absorption of the products of the decomposed urine. So, from being a storage reservoir, the bladder may become a storehouse of poisons, as the result of carelessness and inattention.

THE GENERATIVE ORGANS.

These organs are quite as important in their way as any other organs of the body. They are the organs by means of which life is transmitted from parents to child, and if they are wanting or seriously diseased in male or female that person cannot become a father or a mother. The subject of the reproduction of living beings is a very beautiful one, the development of the unborn human being is one of the most wonderful processes among the many wonderful things which take place in this body of ours. What may the starting of a human life not signify? The launching of a ship is a beautiful and impressive sight, it may forecast journeys over all the seas and oceans upon this planet, it may forecast the downfall of states and governments, and the building of better ones upon their ruins. So is it with the launching of a human life, so therefore should we regard those organs by which alone the launching of new life is possible, treating them with such consideration that their physical well-being and activity may be assured, and that the new life may give promise of good things as it unfolds. Let the teacher and the parent instruct the growing child as to the use and requirements of these organs and the importance not only to himself but to his country of correct views concerning the obligations of those who may become fathers and mothers.

THE HEART, WHICH PUMPS THE BLOOD THROUGH THE ARTERIES.

A most marvelous organ, working night and day, and registering on an average over 100,000 beats in twenty-four hours.

Try and fix in your mind, as the foundation thought about the heart, that it is a pump, automatic, often working many years without losing a stroke, but sometimes, like the best of pumps, having leaky valves and imperfect force and giving results which are most unsatisfactory to the owner. The fluid which it propels is blood, and its task is to drive this fluid through the thousands of tubes called arteries to every part of the body. What makes the heart beat? First of course it is life, for in the dead the heart no longer beats. Then it has an abundant nerve supply and the muscles of which it is principally composed, contract or shorten with the utmost regularity nourished, as they are, by an abundant blood supply apart from the current of blood which flows through them. Their rythmical or regular contraction is its function, the business for which it was made, just as the stomach was made to receive and digest food, the liver to secrete bile, or the piston of an engine to move back and forth. The force of its stroke is such that all these different columns moving in every direction reach their termination regularly, with never a slip, as long as the heart continues to be in good working order. This is no easy task for any kind of a machine. Place the thumb and fingers of your left hand on either side of the larynx or Adam's apple, on either side of the neck, until you can feel a throb or pulse in each place. It is the force of the contraction of the heart sending the blood through the two external carotid arteries. Now keep the fingers there and place the thumb of your right hand on the portion of your left wrist where you have so often seen the doctor place his fingers. If your touch is good you will feel the throb of the radial artery. All three pulsations will occur at about the same time. You might observe the same thing in many other parts of the body where the arteries are near the surface. This means that the blood is being forced through elastic tubes and each throb or beat represents a stroke or contraction of the heart which forces the blood out of its two lower chambers, through two great arteries, on its course over the body. In a grown person the heart contracts about eighty times a minute when one is in health; it contracts more frequently than this in many forms of disease, and less frequently in others. It beats more rapidly after exertion, for the blood flows more rapidly through the lungs in response to the more rapid breathing and consequently is poured with greater volume into the heart. It beats from one hundred to one hundred and ten in little children, and more frequently in women than in men. Fear or any strong emotion will cause it to beat with more than usual rapidity, and if the heart is very weak such influences may cause it to cease beating altogether. Now put your ear to the chest of one of your friends, under the left breast, and listen attentively; you will hear two sounds, the first twice as long and a little louder than the second, then there will be a very short pause followed by a repetition of the sounds, and this will go on indefinitely. With the first sound the two lower chambers of the heart contracted and squeezed the blood into the two great arteries, and at the same instant the valves between them and the two upper chambers closed. With the second sound the valves of the two great arteries closed, the valves between the chambers opened, and the blood in the two upper chambers was squeezed into the two lower ones. Now place your hand where your ear was placed and you will feel the stroke of the tip or apex of the heart against the chest wall each time its two lower chambers contract. You can even see the stroke if the clothes are removed. Suppose you receive an injury, a cut for example, which opens an artery, the blood will not flow out in a steady stream but in jets, and at short but regular intervals. If you will place your hand at the same place on the chest as before you will notice that the jet occurs at the instant the heart strikes the chest wall, and with precisely the same regularity.

HOW THE HEART SENDS OUT THE BLOOD.

Having noted the action of the heart, let us observe the course of the fluid which is in it. The current empties into the right upper chamber through the two chief veins. When this chamber contracts it flows into the right lower chamber. As the latter contracts the valve which is above it closes and the blood pours into the great artery (pulmonary) which bears it to the lungs. The artery divides and subdivides in the lungs, bearing the blood along. Finally the arteries become capillaries, and then the capillaries become veins which get larger and larger, and finally pass out of the lungs, four in number, bearing the blood to the left upper chamber of the heart. From this chamber it is squeezed to the left lower chamber, the valve between the chambers closes, the left lower chamber contracts and forces the blood into the other chief artery (aorta). It is now pumped into the various arteries until it has traversed the entire body, then the arteries become capillaries, and distribute the blood to the cells, the capillaries join the veins and the veins begin to gather up the blood from the tissues and the capillaries. The veins rapidly get larger and larger and finally unite in two great trunks one of which carries the blood from the upper part of the body, and the other that from the lower, both of them finally emptying in the upper right chamber of the heart from which our description began. The circuit of the body by the blood stream usually takes about twenty seconds in grown people, and it was not until the time of the great English physician William Harvey (1578-1657) that this great and important fact became known. The discovery was made in 1619 but was not published to the world until 1628.

When the blood goes to the lungs it is purple or dark red in color, but while passing through their capillaries it gives up the carbonic acid which it contains, absorbs oxygen and is changed in color to a bright red. The bright red color is retained through all its course in the arteries changing to a somewhat darker one in the capillaries, and becoming dark red or purple while going through the veins.

THE LUNGS.

In connection with the lungs we must also consider the larynx or organ of voice, and the trachea or windpipe which leads from the larynx to the lungs. The larynx is the irregularly shaped box in the front portion of the neck, begins at the base of the tongue and extends downward to the windpipe. It is a prominent portion of the front of the neck, especially in men, and is commonly spoken of as *Adam's apple.* It is composed of a set of cartillages held in position and worked by muscles and ligaments. In the lower portion of its interior there are two bands or chords which are joined together in front and are separated by a slight interval at the back. These are called the vocal chords, and their contraction as they are moved by the different muscles and ligaments from the principal element in producing the various sounds which are associated with the voice. When they are inflamed and swollen the voice is harsh and may be absent altogether and when they are in good condition the voice is clear and distinct. Continuous with the larynx is the windpipe both of them being lined with mucous membrane. The windpipe is composed of a series of rings of cartilage, forming a tube four and a half inches long, then dividing into the right and left bronchus. The windpipe and larynx form the channel by which air is received into the lungs in the act of breathing, the air passing into smaller and smaller bronchial tubes until it reaches the very smallest. Attached to each of these terminal bronchial tubes is a lobule or sac which contains minute partitions passing from its side toward the center. Each of these partitions contains capillary blood vessels, and the space on either side of each partition contains air. As the air rushes into the spaces of these sacs in breathing, the blood in the capillaries of the partitions takes out the oxygen which is in the air. This being immediately followed by out-breathing the blood then gives up the carbonic acid which it contains together with a certain volume of watery vapor or moisture, these substances being carried out of the windpipe and larynx and exhaled through the mouth or nose. The entire procedure is known as the act of respiration or breathing. In this act the lungs fall in inspiration, lowering the diaphragm at the same time, and rise with the rising of the diaphragm, in expiration. Twenty times per minute, in a healthy adult person, the chest rises and falls as the lungs are filled and partly emptied of air. Partly emptied I say, for a portion of the air remains, more or less persistently in the lungs.

It is also interesting to note that the vocal chords contract and relax at precisely the same time that the lungs expand and collapse. In in-breathing or inhalation, therefore, there are two things which always occur in a healthy and properly formed individual, the lungs expand and the vocal chords contract, the space between them opening to its widest extent, while in out-breathing the lungs collapse and the vocal chords relax, closing the space which is between them. The number of times per minute that an adult person breathes is not always twenty, it may be many more and it may be fewer. When one has such a disease as pneumonia the soft porous lung tissue is more or less filled with material which has been squeezed from the blood vessels, which is more or less solid. This solid tissue is of no use in breathing, in fact the air cannot get into it. Consequently more or less of the lung is out of commission in this disease, and the more extensive the disease the greater the area of lung which is not in use. Hence one has to breathe much faster in order to get the necessary volume of oxygen, and either this increase of work or the insufficiency of oxygen will soon wear out the enfeebled patient unless help is obtained. In like manner in one of the forms of pleurisy, fluid accumulates in the lung compartment, or pleural cavity, seeks the bottom of the cavity and as it increases presses the lung upward. In this case also the lung cannot expand properly and one must breathe very rapidly in order to get air enough. Certain nervous conditions may also cause one to breathe rapidly, such as fear, grief, laughter, etc. There are also influences which may cause one to breathe very slowly. Poisoning by opium illustrates this condition, the breathing diminishing to three or four per minute and the victim eventually dying from want of oxygen.

Breathing may have an actual influence upon the weight, for the carbonic acid and water, and the organic matter which is dissolved in the water and sometimes gives it a bad color, are taken from the substance of the body and diminish its weight. If this loss were not replaced by sufficient and proper food one would very quickly become thin and emaciated. The chief business of the lungs, then, is to take in air as a sponge soaks in water, to take from it the oxygen which it contains, and give it to the blood. Almost equally important is their work in removing from the blood the carbonic acid and other waste and poisonous materials and expelling them from the body. The lungs are vital organs, that is they are necessary to life, and if they become seriously diseased or injured life will cease. One of them will sometimes do the work of two when the other is diseased or destroyed, but it will seldom happen that it can do it as well, besides diseases which attack one lung very frequently attack both. Fortunately some of the diseases of the lungs which were formerly regarded as incurable are now treated with very gratifying results, and this is especially true of the terrible disease which is known as tuberculosis or consumption. Many surgical operations are also performed upon the lungs which would have been considered impossible or unjustifiable a few years ago.

A VERY WONDERFUL MACHINE WHICH WE SELDOM THINK ABOUT—THE MOUTH AND THROAT.

Did you ever stop to think of the variety of uses which are served by this cavity of the head, and of the great number of parts which it contains? We might call it the doorway or entrance to the place where the food is received, and this used to be called, in my boyhood days, the pantry. There were very few boys, in those times, who didn't know what that word meant and who didn't visit the place, sometimes when nobody was looking.

First come the lips; how much they add to the expression of the face, how they increase its beauty if they are well-shaped and rosy red, and how repulsive they are if they are thick and coarse, stained with tobacco juice, or wanting in cleanliness. What is sweeter or more attractive than the lips of a healthy little child, or a beautiful maiden? The lips are the curtain of the mouth; we draw it aside and the food and drink may enter. We smack our lips when the taste is agreeable, we pucker them when it is disagreeable. They disclose the teeth which are beautiful or ugly as nature has been kind or unkind to us, or as we ourselves have been careful or inattentive in our treatment of them. They bite and chew and grind our food for us, they assist us in talking and when they are gone what a loss and inconvenience and misfortune we suffer. Then there are the salivary glands which we cannot see but which are constantly busy in providing the fluid which keeps the mouth moist, softens the food, and helps to prepare it for the nourishment of the body. The tongue, too, must not be forgotten, for it helps us in talking, rolls the food about and tells us whether it is something we like or something to ''make faces'' about and get rid of as soon as possible. Imagine how inconvenient it must be to lose the tongue, and this is a misfortune which disease brings to many. How helpful, too, it is to the doctor in his efforts to find out the nature and the cause of the sickness which may be troubling you. Most important, too, is the throat which receives the food after it has been chewed and moistened, grasps it so that it can not get away, and squeezes it into the gullet to be carried to the organs which will convert it into nourishment for the body. Through the throat also passes the air which is to supply the lungs and the blood and the whole body with the life giving oxygen, and the throat also bears its share in the acts of talking and singing, and all vocal sounds. A very wonderful machine is the mouth and throat.

THE USEFUL NOSE AND WHAT IT IS FOR.

The first use of the nose which would occur to us is its importance as one of the features of the face.

Without a nose the face is a hideous object, it is slightly improved when a portion of it remains, even though it may be flattened by disease, mis-shapen, or partly destroyed. When it is fully developed it is a prominent characteristic in the countenance; in fact same races are recognized by the shape and prominence of the nose. Sometimes it is grotesquely large, red as a beet, and shines like a beacon in the night. Such a nose was that of Bardolph, intimate of Jack Falstaff who said of him "But 'tis in the nose of thee; Thou art the Knight of the burning lamp." But whether it be beautiful or ugly its usefulness cannot be questioned; in it are implanted the ends of the nerves which are the means of interpreting to us sensations of smell. If this sense impresses us with that which is disgusting and repulsive and malodorous, it also delights us with the fragrance of flowers, of the new-mown hay, and all the other agreeable impressions which nature offers through the sense of smell. The nasal cavity is also the channel through which the air of the atmosphere passes to the lungs, at least when a person is in health and the nasal passages are properly constructed. We should breathe through the nose, not through the mouth, for thus the air is filtered of impurities on its passage downward and at the same time is properly moistened and warmed. Breathe for awhile through your mouth and see how dry and uncomfortable it becomes, because it was not intended for that purpose except in emergencies. This explains why those who must breathe through the mouth are more likely to acquire infectious disease than those who breathe through the nose, and why children who are mouth-breathers are sick and miserable so much of the time. Another advantage of the nose which I will venture to say, you have never thought of is that it furnishes a road to the stomach when the mouth can not be used. Suppose the jaws were fastened together by disease, suppose a person refused to eat, as sick and crazy people often do, the doctor can easily pass a tube through the nose and down the throat and through this he can pour into the stomach as much fluid food as he may think best. Again when a person is unconscious and unable to swallow this way of introducing food into the stomach is of great value.

THE EARS—THE TWO SENTINELS OF THE HEAD.

As a face without a nose is disfigured so is it also disfigured if the ears are wanting. It is not three hundred years ago since it was the custom in England to clip off the ears of those who were not in sympathy with the government, and to this barbarism was sometimes added the cheerful operation of slitting the nose. Even those cruel jokers appreciated the importance of these structures to every individual and made their punishment the more impressive by thus constantly calling attention to their disapproval of certain lines of conduct. The ears stand out like sentinels on either side of the fortress where dwells the ruling portion of the body. They are not absolutely essential to hearing, any more than the nose is to smelling, but they collect the waves of sound which approach them and render the hearing more acute than if they were not there. The ears are very often the seat of disease especially in children. A very common disease at the present time is one which attacks the middle ear which may demand a serious surgical operation, and may even be fatal. Scarlet fever often involves the ears and not infrequently results in permanent deafness. Children frequently injure their ears by putting stones, or beads, or even living bugs in them. Hence the importance of very early teaching by the parents to protect an ignorant child from the result of his folly. This can only be done in the home, for such mischief usually occurs before a child is old enough for school and for the influence and advice of a teacher.

THE EYES—THE MOST DELICATE, WONDERFUL AND USEFUL OF THE ORGANS OF THE BODY.

If you were to be asked what portion of the human face carries the most expression you would probably answer—the eyes. It is not exaggeration to call them the gateway of the soul, for if there is any portion of the body which can reveal to the outer world the true nature or soul of an individual, it is the eyes. Think of the variety of colors they have, black as night, blue as the sky, red as blood, pink as a rose, gray as the clouds, green as grass and many shadings from these colors. How expressionless the face when the eyes have been taken out, unless there be the expression of despair! How pitiful the expression of the blind, staring into space and seeing nothing! How beautiful the eyes of a maiden looking into the face of her lover, or of a mother looking into the face of her new-born baby. How the anger of a strong man shows itself in the *fire* in his eyes, and how the eyes of others express greed, cunning, and sensuality, or on the other hand, seriousness, benevolence, and usefulness. We often associate certain expressions of countenance with certain animals, cunning in the fox, innocence in the lamb, stupidity in the donkey, docility in the dog, courage in the lion, but, however forcible these may be in the animals they are intensified in the human being, and is it not for the reason that in the latter there is the human eye which does most of the work of expression and has a soul behind it?

The sense of vision is by far the most important of the senses. Its loss to the average person, especially if it comes in mature life, when one has long depended upon it for indispensable help in doing the daily tasks, is like consigning him to a living tomb. To be sure much has been done to educate the blind and take them from the company of the helpless, and many of those who have been blind from infancy or childhood are able to live and work with comparative comfort, and at many occupations, but the education of those who have lost their sight in mature or advanced life is extremely difficult and often impossible. They do not, as a rule, have sufficient confidence in themselves to educate their fingers to read, and they have passed the time when they could take up employment with advantage. The eye takes note of the most distant as well as the most near objects, and it suits itself to the distance of the object by what is known as accommodation. Wonderful is the power which enables it to detect different shades of color; wonderful that which enables it to study, with proper glasses, the mighty heavenly bodies at distances almost infinitely remote and the infinitely small animals and plants which are seen only with the aid of a powerful microscope. The eye being an optical instrument and being subject to the same laws of growth and decay which govern all other parts of all things which are possessed of life, varies in its power of vision in different individuals, and at different periods of life. Young people are often near-sighted, that is their eyeballs are somewhat flattened, and an object which is looked at is most distinct when placed nearer to the eye than is necessary when the eye is mature and normally developed. Such people must wear glasses which will carry the object forward, and then they can read and distinguish faces and other objects the same as if their eyes were normal. Old people on the other hand, are far-sighted, the eyeball is lengthened, and they must wear glasses which brings an object nearer to them in order to see it with distinctness. Those whose eyes are normally developed can see objects with distinctness at ordinary distances and do not need the help of glasses. Their power of accommodation also changes readily from one distance to another, within certain limits of course, as that of near-sighted and far-sighted persons does not change. The eyes are subject to many diseases but so great have been the advances in the study and treatment of such diseases that loss of sight is far less frequent from such causes than it used to be. Young people ought to be taught to use their eyes properly, that is in such a way that the light will be sufficient, and not too great nor too little, nor coming from the wrong direction. It is a great blessing that in so many towns and cities the eyes of school children are inspected by skilful doctors from time to time, and that they are fitted with proper glasses when they require them. It means much, not only for their health in the future, but also for their ability to get a living and to serve their country as good citizens should always do.

THE SPINAL CORD.

You will remember that this organ is a kind of continuation of the brain, that from it spring or sprout thirty-one pairs of nerves which send branches to all portions of the body, that sensations travel from the surface of the body along the nerve fibers to the posterior root of the nerve in the spinal cord, then up the spinal cord to the brain, then back again, down the cord, to the anterior root and out to the proper muscles, causing them to contract and produce motion. You will also remember that it is connected with the sympathetic system, and so brings the nerves of that system into communication with the brain. It is therefore like a line of telegraph wires leading to a central station, bearing messages to it and taking messages from it, or like a bridge which joins the capital of a State with the remaining parts. In these days when injuries of the spinal cord are not very rare, it may be interesting to know what results may follow such injuries. An injury which cuts the cord in two is a very serious one. All the body, in a person so injured, is helpless below the injury, with power neither of motion nor of feeling. Neither is there any control over the rectum and bladder, the victim is as helpless as a baby with respect to these organs. If only a portion of the cord is divided the loss of power will be on the injured side. Sometimes the loss of motion will be on one side and the loss of sensation on the other. Only recently we saw a policeman who was shot while attempting to arrest two men engaged in a fight. His cord was almost entirely divided and although he is living he is perfectly helpless below the level of the injury. He may live for years but this portion of his body is of no more use to him than if he were dead. In some respects it is a condition worse than death for he must have constant attention in order to keep him clean.

In addition to being a bridge or a series of wires for the transmission of impressions and impulses the spinal cord may be in itself a center or headquarters for certain actions, this center being located in the cells of the gray matter which is in the interior of the cord. It has no power of will like the brain, but under the influence of certain diseases or poisons, and also from other causes, there may be what is called reflex action. Experiments which prove this have often been made upon animals and also upon criminals who have been beheaded. We once saw a criminal in Paris who had been beheaded, who was thus experimented upon. In the case of animals, suppose a frog is beheaded, his head is gone and his brain is gone with it, therefore his brain can exert no power over motion, but if you pinch or tickle his foot he will draw it up, and if you pinch hard enough he may move all his limbs and perhaps other parts of his body also. This proves that sensation still remains and that an impression of sensation must have been felt in the cord which was followed by an impulse down the cord producing motion. In the disease called tetanus or lock-jaw reflex movements or spasms are very common and very painful and the disease is usually fatal. Many of the ordinary movements which we make in walking, running, etc., are reflex movements, being performed without any thought of what we are doing, in fact our thoughts may be entirely occupied with something else.

THE KING AND RULER OF THE BODY—THE BRAIN.

It seems fitting that we should conclude our consideration of the structure and work of the various parts of this wonderful organism which we call the body by the consideration of that organ which is the king of them all, the brain.

We told you in one of the early chapters that plants grow, animals grow and feel, and human beings grow and feel and think. It is the power of thought that chiefly distinguishes man from the animals and he has that power not merely because he has a brain but because his brain is far more highly organized and developed than the brain of any animal. Remembering now what we told you about the construction of the brain and spinal cord and also what was said about the passage of impressions from the surface to the brain and back to the muscles, let me be a little more particular and state that an impression having travelled up the fibers of white matter of the spinal cord on one side crosses to the other side of the middle line when it reaches the medulla oblongata or that portion of the brain which is immediately connected with the spinal cord. From that point it passes onward through what we told you were the ganglia of the brain and thence to the convolutions or irregular folds which form the outer portion of the hemispheres of the brain, where it becomes conscious thought and is sent down again to be converted into action. Note also that the impression may be switched off before it reaches the realm of thought and then, when returned, becomes an unconscious or reflex act. This may take place either in the cells of the gray matter in the interior of the cord or in those of the ganglia of the brain. In other words it would seem that wherever there are cells of this mysterious gray matter in the nervous system, or perhaps we should more properly say collections of gray matter forming ganglia then we have centers where impressions may be received which can be converted into impulses and action. The brain grows like every other part of the body, and it does not attain its full size until mature life has been reached. The larger it is, and the more it is used, the more work, as a rule will it do. Sometimes it is not mere weight or size alone which determines its power, but the number and extent of the foldings and twistings, called convolutions which form the outside or cortex of the hemispheres or *cerebrum.* An idiot has very small hemispheres and they do not grow as the rest of the body grows. That is the reason why idiots are unable to do anything which requires careful thinking. It is in the hemispheres alone that thought takes place, and so we are correct in saying it is the seat of the mind, and of all the properties or qualities of the mind, such as memory, reason, will, judgment. This is proved by the fact that when large portions of the brain are destroyed, even though the person may not be killed, he cannot do the things which can be done by one whose brain is uninjured.

One of the mysteries of life consists in the way in which the brain acts to produce thought. We can see the result of thought, but no one has yet been wise enough to tell us what takes place in the brain while thought is being made. There are some things however which have been learned about the work of the brain, chiefly by experiments upon animals, and the particular kind of work which is done by certain portions of it. By exposing the brain of animals and passing a current of electricity through different parts it has been found that when certain parts were thus irritated certain muscles would contract and motion would occur. Careful study of such facts has enabled us to locate the exact place or center which controls the motions of many of the different portions of the body. Other experiments have made it possible to locate the different centers which control feeling and speech. These experiments have been verified in human beings who have met with accidents or injuries which have destroyed these centers, and have been followed by the same results which followed the injuries produced upon animals. It has often happened when a person has had a hæmorrhage into the brain, which is commonly called a stroke of *apoplexy* that certain muscles are paralyzed, or that sensation in certain parts is destroyed, or that speech is no longer possible, and the skillful physician will be able to say in either case, just what portion of the brain has been injured, and perhaps say what the result is likely to be. Experiment has also taught us that the cerebellum, which is the portion of brain behind and below the hemispheres, controls the muscles which enable us to perform the different motions which are necessary in walking, running, etc., and that when these are impossible it is because the cerebellum has met with serious injury. The small mass of brain matter below the cerebellum, which is called the medulla oblongata, is perhaps the most important of all, for it controls the breathing, the swallowing, the sounds of the voice and the framing of them into words. If this small organ were seriously injured death would result instantly and if the injury were slight it might give one great difficulty in doing any of the important things over which it exercises control. In order that the brain may do good work it must have proper care, good food, exercise and rest. The brain is not only the organ by which active work is accomplished in thought, in planning, desiring, hoping, constructing, in anything which requires mental effort and energy, but it is like the sensitive photographic plate which receives all kinds of impressions. If the brain were unconscious we would not have the various emotions and sensations of joy, sorrow, pleasure, pain, fear, anger, heat, cold, and all the rest. The living brain makes us conscious of these impressions, and not only conscious but it reflects them upon the other portions of the body. Fear sends a message to the heart through the pneumo-gastric nerve and makes it throb and palpitate, it sends a similar message to the stomach and stops digestion. Anger through the influence of the nerves, loosens the blood vessels, and sends the blood in a torrent to the face and head, reddening the face, and perhaps producing a hæmorrhage. Grief causes the tears to flow, joy brings laughter and none of these things would occur if the brain had not received a message and translated it in these various methods.

The brain must not be overworked, it must not be poisoned with alcohol or other injurious substances, its blood supply which is its food must be sufficient but not too great, and after a period of labor there should be a period of repose, cessation of effort, sleep. Sometimes the brain works with great activity when the body is feeble or racked with pain, but this is unusual for in the majority of cases it shares the experience of the other organs and works in harmony with them, suffering when they suffer, rejoicing when they rejoice. Remember that it is owing to the work of the brain that the world is no longer a wilderness and that the achievements of life, good and bad, have been possible, because man has a brain and has learned how to use it.

PART III.

The Care of the Human Body.

CHAPTER XIII.

Health and Disease.

THE GREATEST TREASURE THAT HUMAN BEINGS HAVE.

DO you know what that is? Some of you will perhaps say precious stones, like diamonds, or fine clothes, or nice houses with beautiful gardens, or what comes to the same thing as all these, lots of money; for with enough money you can, under certain circumstances, buy any or all these things.

Please notice that we said that with enough money you could buy all sorts of things *under certain circumstances.* Suppose you were on a deserted island, like Robinson Crusoe, and had as much money as the richest man in the world, what satisfaction or enjoyment do you think you would be able to get out of it? Without other people to sell you things you would not be able to get anything with your money that you could not get without it; and you could neither eat money nor wear it, nor live in it. So you see, such things have only a relative value, that is, a value that depends on your coming by means of it into some kind of relation with other people, and even on the nature of that relation; for if the other people were robbers who wanted to take them from you and were perhaps willing to kill you to get them, you would be only too glad to be rid of them; and if they were ignorant people who thought all your fine things silly, you would

An Unwilling Patient.

soon get tired of them and cease to have any pride or pleasure in them.

The greatest treasure, then, can not be anything that depends for its value on your relation to other people; it must be something that has to do with your relation to yourself, something that will affect *you* and help you on to happiness and real enjoyment of life. That treasure is HEALTH.

Of course, to keep health you need shelter from cold and wet, clothing, food and drink to enable you to grow when you are young, and when you are older to make up for the wear and tear of your body which takes place by use, and to make your body do its work; also fresh air, the oxygen gas in which burns up the food you take into your body to produce heat and power, which are necessary to the activity of the body, just as fuel and air are necessary in the furnace to make the fire that turns the water into steam, which gives an engine its power of movement. Exercise also is necessary, or your body will get out of gear, as a disused engine will rust and clog and become unworkable if left unused and exposed. But if you have health you should be able to get all these things by working for them. But if you could not get them you would soon lose your health, and then you would be no longer able to enjoy life in comfort and with a sense of well being. So you see, it all comes round again to the necessity for health. But if you *have* health, comparatively little of these things is all that is really necessary for you to keep it, and that which is really necessary is not very costly; while, without health, you can not get these things for yourself, and even if you had them without the necessity for getting them you could not really enjoy them.

WHAT, THEN, IS HEALTH?

Health is that condition of the body in which it does all that is required—or rather that *ought* to be required—of it regularly and without any knowledge on your part that it is having to do it; when the body answers to the needs of life or to your will without any noticeable effort on your part. For instance, the food that you eat is worked up in your body into different materials, some of which are useful and are kept to make the body grow, or to replace those parts used up in the wear and tear of body work. This is called digestion and assimilation. The remainder, which is useless, or even perhaps harmful, is expelled by the bowels, in the urine, by the breath, and by the perspiration. This process is called excretion. You don't have to think about it; your body just goes ahead and does it. If you want to run after a ball, in order to move your body and legs in that direction certain of your muscles have to contract and move your legs, and so you run. When you are in health you do not have to think how to do this; you just run. Of course when you are learning to do a new thing, as for instance to write, you have to pay attention to what you are doing, that is, to what you want your hand to do, not to how the muscles of your hand manage to do it; of that you are unconscious.

HOW DOES AN INFANT BEHAVE WHEN IT IS HEALTHY?

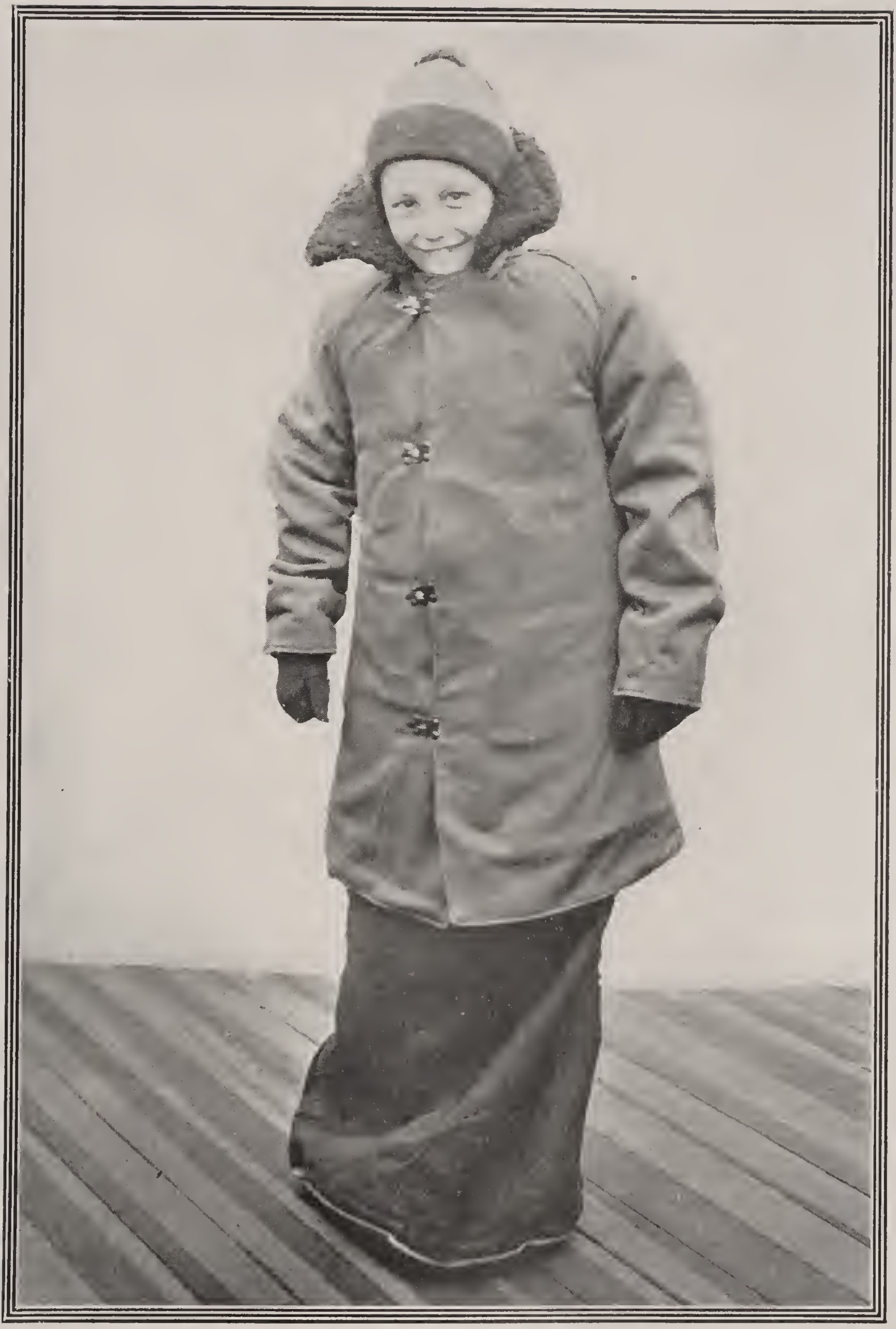
When an infant is healthy it sleeps about twenty hours out of the twenty-four, and takes its food well at regular intervals. A baby increases in weight and size every week, if in health, until at the end of a year it is about three times as heavy as when it was born. In a few weeks after birth it begins to take interest in its surroundings, recognizes its mother if she nurses it, takes its food eagerly, and learns to smile and coo to itself. When it is not hungry or in pain (as from a pin pricking it) it does not cry, but seems happy and contented. It kicks its legs about and moves its arms and seems delighted to find out its own power of movement. It breathes freely through its nose and does not snuffle. Its life is one of progress. It learns to hold up its head, to sit up, to crawl after things. Soon it lays hold of something and pulls itself up. First it stands, then it puts one foot forward, and soon it learns to walk. But all the time it is happy, because its body is working well, and it is not old enough to have those causes of unhappiness that make older people sorrowful.

When the child is a little older it romps and plays with its fellows. How active it is, and how it delights to skip and run and jump and shout! It is being active, that is, it is letting life "work well." How hungry it gets, and how it enjoys its food! Watch the excitement in the eager faces of children in their play! How intense and real it all is to them! And how tired they are at bedtime! Asleep almost before they are in bed, sleeping soundly and quietly the whole night through.

As the boy and girl grow older, new interests arise, but there is the same letting of themselves go, the same desire to "do things." They are happy and contented, smiling and rosy-cheeked, capable of doing any reasonable and proper thing that is set them to do—if they are healthy. They, too, take their food well and digest it without knowing anything about it. They sleep well, and when awake are alert and active both in body and in mind. As their minds develop, however, they are more susceptible to causes from outside themselves that may produce distress, but unless these causes continue too long, the working of their bodies is not affected and they remain in good health even though for a while unhappy.

WHAT CAN CHILDREN DO TO KEEP AND IMPROVE THEIR HEALTH?

Children can learn to do a lot to keep and even to improve their own health. The things that a child who wants to take care of its health must have, are cleanliness, fresh air, exercise and rest, food, good habits. A most important thing is to keep the skin clean, not only the hands and face, the parts that show, but even more, the parts of the body that are covered. Besides protecting the internal organs of the body, the skin is part of the great sewerage system of the body, by which the waste material is got rid of through the perspiration. There are millions of little holes in the skin through which the perspiration escapes, and if these holes are blocked up by dirt the waste can not escape thereby, and either remains in the system to poison it, or the extra work of getting rid of it has to be done by other organs, such as the kidneys, which separate and discharge another part of the waste in the urine, and thus they have extra work to do and are liable to break down in consequence. Moreover, boils are apt to form from the blocking up of glands, germs which are a cause of infectious disease find a good breeding place there, and also lice and other foul insects breed there, causing itch and other skin diseases. Then, too, the heat of the body is controlled by the evaporation of the sweat. Now, all these functions are checked if the skin is prevented by dirt from working properly. The hair and nails, the eyes and ears also should be kept clean. Besides washing the hands and face, therefore, in the morning, and the hands at least always before eating, one should have a hot bath with plenty of soap and water and a good rubbing with a rough towel afterwards at least once a week. It is a very good plan after bathing before one leaves the bath to have cold water poured in. A cold bath every morning is a good thing—not to stay in, but merely to plunge in and out again, or to sponge down with cold water—but only for those who have a glow and feel quite warm afterwards. If one feels chilly afterwards it is a sign that the cold bath does not agree. The teeth should be cleaned twice every day (on getting up and going to bed), and better still,



I AM GOING TO SLEEP OUT-OF-DOORS.—Showing a youngster ready to spend the night in the open air. The lad, wearing his underclothes and stockings, hops into a sleeping bag, the bottom of which has been thickly lined with hay. There are a couple of blankets on the inside of the bag, which are drawn up to his neck and buckled under his armpits. Then the external portion of the bag is buttoned around him. Next, he dons a coat of warm material lined with fur and having a collar and wristlets of lambswool, the latter so arranged that they can be snugly drawn around the wrist or over the hands. Finally, there is a knitted woolen Cap, that protects the ears and neck if the weather is very nipping. Copyright by Underwood.

after every meal also. A fairly stiff brush should be used, which will get into the crevices between the teeth and brush away the particles of food that stick there and begin to decay, injuring the teeth and also often forming breeding ground for germs. The teeth should be brushed up and down, not across.

The more you can be out-of-doors the better. The air indoors always gets unwholesome from people breathing in it and from the animal waste thrown off from the skin by perspiration, for there is always *some* perspiration going on, even when you can not feel it. So don't be afraid of out-of-doors, even in cold weather. Even when the weather is wet it is not harmful so long as you can keep yourself quite warm by exercise, and your feet dry.

Every living thing grows by being properly exercised and tends to waste from disuse. You know how big the muscles of the arm, for instance, become when constantly used. So it is a very good thing to practise physical exercises under a competent teacher, so as to bring into use all the muscles of the body in turn. This will also increase the circulation of the blood in them and cause them to grow; it will strengthen your control over your own muscles, and create a quickness of response in them.

Proper rest is just as necessary as exercise, to allow the body to repair its waste. Children should never stay up late. They need a lot of rest and sleep. Do not be afraid of an open window in the sleeping room; windows should always be opened at the top, not at the bottom. Keep your body warm with plenty of bed covering. Outside air is nearly always purer than that in a room. You should breathe through your nose with your mouth shut. If you can not do so there is something wrong and you should see a physician.

Eating should never be hurried. It is quite common with children to want to hurry over their food and get off to their play. This is a very bad habit. During digestion the stomach needs an extra supply of blood, and to secure this, the remainder of the body should be given a rest while the stomach works. Eat slowly and chew your food well; it will digest better and you will feel the benefit of it. Fatty food is good, and all children should train themselves to eat a certain amount of it. Don't clog the stomach with too many candies, or indeed with anything between meals. The stomach needs rest as well as the rest of your body; so, when it has done its proper work and has digested your meal, let it rest until the time comes for the next meal.

Finally, as to habits. If you push your way through the underbrush in a wood, at first you have a little difficulty in getting along; but after you have gone the same way a few times, a path becomes trodden and it is easier to go the same way again. So it is with all the actions that we call habits. Every action of the body (or mind) means that at first an impulse has to work its way through the substance of the brain. Every time that action is repeated the path becomes more and more clear, until at last a repetition of the action becomes quite easy. If you get into the way of doing anything by doing it often, very soon it becomes a habit. You can see, therefore, how important it is that you should begin early in life to form good habits and to avoid forming bad ones. Practise self-control, that is, do nothing on impulse, but always check your impulses until you are sure you are going to do what you think is best. Get into a habit of standing and sitting properly, of walking properly, and above all, of breathing properly. What the right modes of sitting, standing, walking, and breathing are, your teachers will tell you. Govern your temper, for ill temper causes more trouble to the health than most people are aware of. The creation of good habits and the avoidance of bad ones have a great deal to do with the preservation of health.

CAN CHILDREN INHERIT HEALTH FROM THEIR PARENTS?

Health is a relative term. It is hardly correct to say that children can inherit health, because health is the result of two separate factors: (1) a tendency on the part of the body to perform its functions properly; and (2) the favoring or hindering influences of our surroundings.

The tendency is inherited, but in a greater or less degree; and in proportion to its strength the body easily adapts itself to those influences in the surroundings that make for a good result and resists those influences that make for a bad one. The degree of health attained depends on whether the natural tendency and the good influences or the evil influences are the more powerful. This is on the whole fortunate, because to a great extent it is in our power to fall in with the good influences and to avoid the bad ones. A child born of healthy, vigorous parents is as a rule healthy, and its natural tendency is to perform its functions properly, and it will do so unless external influences act upon it in a way to counteract that tendency.

HOW DO SURROUNDINGS INFLUENCE A CHILD'S HEALTH?

Health is very much influenced by the place in which, and the circumstances under which, a child lives. Children who live in the country have a better chance of keeping health than those who live in a city. For what a child most needs is sunlight, fresh air, exercise in the open, and good food. Now, in the country the houses are not shut in as they are in the city, the air is better than that of the city, there are more opportunities for the child to get out-of-doors to play, and milk and eggs and vegetables, all particularly good foods, are, as a rule, cheaper. In a city there is greater likelihood of overcrowding. Rent is dearer, and therefore more people are crowded into one room, and if there happens to be a spare room, instead of its being used to lessen the numbers in a room, it is quite likely to be let to lodgers. The habits of the grown-up people also affect the child's health. If they are careless and untidy, not only is the child likely to be so, but he is neglected and often dirty. Most of the children who have lice in their heads or on their bodies come from houses where the elder people have little sense of cleanliness and self respect. If the water supply is defective and the drainage bad we have conditions that favor infectious diseases.

CAN HEALTH BE BOUGHT?

If health *could* be bought do you think there would be any sick people among the very rich? Yet very many of them have very ill health themselves or in their families. Of course it is a great thing to have money enough to do all necessary things or to buy whatever is wanted to restore health. A journey to the seashore or to the mountains, plenty of good food, rest, and the best of nursing and medical attendance can all be got with money. But even these things will not make certain the restoration of health or prevent one from becoming diseased. Then, too, wealth often brings disease of its own, from nervous overstrain or overindulgence, etc.

THE VALUE OF HEALTH AS COMPARED WITH MONEY.

There can therefore be no comparison of the value of health with that of money, for without health life loses its charm, and also instead of being a help to others we tend to become a burden to them in time, patience, and money.

WHY DID THE ANCIENT GREEKS AND ROMANS PRIZE HEALTH ABOVE ALL THINGS?

The ancient Greeks laid so much stress on health that gymnastics occupied as much time as all of the other subjects of education put together. We are told that "the ancients, and more especially the Greeks, seem to have been thoroughly convinced that the mind could not possibly be in a healthy state unless the body likewise was in perfect health, and no means were thought, either by philosophers or physicians, to be more conducive to preserve or restore bodily health than well-regulated exercise.'' Again, ''the great partiality of the Greeks for gymnastic exercises was productive of infinite good; they gave to the body that healthy and beautiful development by which the Greeks excelled all other nations, and which at the same time imparted to their minds that power, and elasticity which will ever be admired in all their productions.''

THE BEARING OF OUR HEALTH ON OUR USEFULNESS AS CITIZENS.

You would all like to grow up good citizens, wouldn't you? To be a good citizen is to do your duty to the State; to be able to take your share of the world's work. For a certain amount of work has to be done either by or for each person who lives in the world, and unless each one does his share someone else must do more than his share to make up for it. The history of the word idiot shows clearly what the ancient Greeks thought of the man who did not do his citizen's duty. The Greek word from which the word idiot is derived, meant originally a private person, one who did not take his share of the public duty. He was regarded as a senseless person because he was useless to the community, so the meaning ''without sense'' came at last to be its ordinary meaning.

DISEASE, THE GREAT ENEMY OF THE HUMAN RACE.

You all know what ease is when you feel perfectly ''fit'' and are free from any sense of discomfort. At such a time you are unconscious that you possess any body organs, they all work so well that you do not feel any effort in their working. Your heart beats without you noticing it; you breathe without noticing it; you run and sit and jump and stand and talk, all without any conscious effort. You know, however, that if you overdo—by running too long or too fast, by eating too hastily or eating improper food—you then become conscious of the effort of your heart to beat, it throbs and pounds; of your lungs to breathe, your breathing becomes labored so that you draw your breath with difficulty and are conscious of it. You get tired, too. And when you have overeaten or improperly eaten, you feel a sense of fulness and weight that draws your attention to your stomach. Now, such a passing derangement is hardly disease, as we use the term, though it is certainly dis-ease. But when such conditions become lasting, remaining with you even when you have not been taking too hard exercise, or overeating, or eating improperly, etc., then there is something wrong with the working of your body—you are diseased. Disease, then, is a condition in which the body (or mind, for the mind, too, may become diseased) is not able properly to carry on all these activities which it ought to carry on naturally and without noticeable effort.

DO CHILDREN GET DISEASE FROM THEIR PARENTS?

Some forms of disease are said to be hereditary, that is, to be passed on from parents to children, and from them to their children, and so on for many generations, until either the disease gets gradually worn out or the race perishes. Certain diseases do truly "run in families," but of late the studies of scientific men seem to show that some diseases which were for this reason thought to be inherited, really only run in the same family because members of the same family when living together are exposed to the same exciting cause. Until not long ago it was thought that children born of consumptive parents were born consumptive, so that when the disease later broke out in them every one said: "Poor thing! What could you expect for the child with a consumptive father (or mother) like that?" But the study of this terrible disease, which is called "the great white plague," shows that the real cause is that consumption (or tuberculosis of the lungs) is "caught" by the children of consumptive parents from being so much with them and kissing and caressing them, and breathing their breath, or by dust from the dried-up little drops of saliva that they shed in coughing, and so on. It is indeed very likely that such children do inherit a constitutional weakness which renders them less able than other children to resist the exciting cause. There are other diseases, however, which seem as though they were actually inherited. For instance, there is a disease called hæmatophilia, or the "bleeder's disease," which consists of a tendency to bleed severely after slight injuries, such as in healthy people would cause only very slight bleeding which would stop of itself very quickly. Also color blindness, which makes a person unable to recognize certain colors, appears to be really handed down through parents to children. Some forms of insanity also appear to be truly hereditary.

DISEASES COMMON IN CHILDREN.

Many diseases are particularly common in children. The most common are those which are due to improper feeding. Summer diarrhœa kills numbers of infants, principally in cities, during the hot weather. Rickets, a disease in which the bones are too soft and tend to bend, is largely due to lack of fresh air and sunlight and to improper feeding. In scurvy, a related disease, there is a tendency to bleeding, especially in the gums, which become swollen and tender. Convulsions often occur in children. Children often have their tonsils (two fleshy lumps at the back of the mouth, one on each side, which you can see if you open your mouth before a looking glass) swollen, and this interferes with proper breathing and renders them liable to diseases of the lungs. In the cavity behind and above the tonsils at the back of the nose passage, lumps of jelly-like material (called ''adenoids'') often grow. These prevent the child from breathing properly through the nose and cause him to be a ''mouth breather,'' that is, one who habitually keeps his mouth open, a very unhealthy habit. Chorea, or St. Vitus's dance, is a disease of the nervous system; it affects the muscles of the whole or a part of the body and compels them to keep constantly twitching. Epilepsy, or fits, is another nervous disease, very difficult to cure. Headaches are very common. They arise from many different causes, such as bad eyesight, an unhealthy condition of the nose and throat, indigestion, poor blood, rheumatism, imperfect nourishment, nervousness, and especially from causes which arise at the beginning of serious diseases, such as fevers, diseases of the brain, etc. Overheated, badly ventilated rooms may cause them. Many diseases of the skin occur in children. Some are due to digestive derangements, but many of them, such as head lice, body lice, itch, ringworms, etc., are caused by parasites, that is, by animal or vegetable beings that live on human beings. Finally we have the group of infectious diseases, that is, diseases that are ''caught'' from other people, such as measles, scarlet fever, diphtheria and croup, pneumonia, chicken pox, smallpox, whooping cough, typhoid fever, mumps, tuberculosis, or consumption of the lungs, bones, or other organs.

CAN DISEASE BE PREVENTED?

One of the grandest achievements of this modern age of ours is the development of the science of hygiene and sanitation, that is, of the prevention of disease, both in individuals and in communities. By hygiene we prevent disease in the individual by strengthening the resistance of the body to injurious influences, thus overcoming the predisposing causes of disease. By sanitation we try to do away with, to overcome, or to render harmless the exciting causes of disease. Typhus fever, a fearful pestilence that was once very common in jails and overcrowded parts of cities, has now almost entirely died out in Great Britain and America. Smallpox used to be so common that it is said that about one person in every five was pitted with it. When you remember that that represents only those who recovered from a disease that was so deadly, that in the fifty years preceding the introduction of vaccination, ninety-six out of every thousand deaths that took place were due to smallpox, you will have some idea of how fatal it was, and what a great blessing is vaccination. How many persons do you children remember having seen disfigured with smallpox? Very few, I am sure. Nothing like one in five of all the people you see.

Sanitation teaches us the necessity of pure air, free from dust and hurtful gases; pure food, especially pure milk and water, and thoroughly cleansed vegetables; removal of all sewage, especially the body waste of human beings and other animals, which is likely, if not properly disposed of, to soak into the ground and get into drinking water or to be carried by flies and other crawling or flying insects and deposited in food; and the protection of people from mosquito bites by which the germs that cause malarial fevers and yellow fever, are implanted in their bodies.

IS DISEASE EVER USEFUL?

Vaccination protects us against smallpox, hypertrophy of the heart compensates it against undue resistance to its function. Bleeding at the nose sometimes is useful to lessen blood tension in the brain, and thus obviates brain hæmorrhage and paralysis. Diarrhœa is one of nature's methods of getting rid of offending bodies from the intestine.

DO WE KNOW MORE ABOUT DISEASE THAN OUR FATHERS DID ?

We have learned a great deal about disease that our fathers neither knew nor suspected. We know that consumption is not hereditary as was formerly supposed. We know the causes of many infectious diseases and how to prevent them; how to produce immunity against many diseases, that is, how to bring about a condition of the body so that it is not likely to catch certain diseases even when exposed to them; how to stamp out smallpox, malaria, and yellow fever.

VIEWS FORMERLY HELD ABOUT DISEASE.

A long, long time ago all people believed that disease was a plague sent either by angry gods or by evil spirits, so they tried either to make them friendly by offering sacrifices to them or to charm away the evil spirits. Then it was taught by Hippocrates, a wise Greek physician, who lived over four hundred years before the birth of Christ, and was called the ''father of medicine,'' that just as the universe consisted (in his opinion) of four elements, Fire, Air, Earth, and Water, so man consisted of four elements, the blood, which gave heat, the mucus which gave cold, yellow bile which caused dryness, and black bile which caused moisture. Health was supposed to be due to a proper mixture of these elements, and disease was due to a change in them. Others attributed disease to a derangement of three spirits—the animal, the natural, and the vital—in man. Then it was supposed that all diseases were due to debility or weakness and were to be treated by strengthening the system, while others regarded them as due to over strength and needing lowering measures, bleeding, purging, vomiting, etc.

WHAT CITIES AND GOVERNMENTS ARE DOING TO CONTROL DISEASE.

When people leave scattered homes in the country and begin to crowd together in cities, two of the most important needs are means for the removal of refuse and a proper supply of pure water; so sewerage systems and waterworks are constructed. Another important thing is to prevent the adulteration of food or the selling of food unfit to eat. So the dairies are placed under supervision that the milk may be kept clean; animals to be killed for food are inspected by an official to see that they are not diseased. Baths and public washhouses are established. The health department watches all cases of infectious diseases and "quarantines" the house, that is forbids strangers to go to it so that the disease may not be caught by others. If the sick person dies, or when he gets well the house and everything in it is disinfected, to kill the germs and prevent the disease from spreading. Streets are watered to lay the dust, for dust is a great carrier of disease germs. Laws are made to prevent spitting in public places, because the spit often contains disease germs which dry and are blown about in the air and breathed by people. Public playgrounds are provided for children. Children are taught hygiene in the schools, that they may understand their own bodies and what things help the body to work properly and what prevent it, so that they may act more wisely than our fathers used to do. Another great thing is the inspection of children by school doctors, so that not only infectious diseases may be prevented from spreading, but serious disease of any part of the body may be discovered early enough and treated in time. This is very necessary, because often very serious diseases do not make people feel very ill or suffer much at first; and when they get really bad it is very much harder and sometimes impossible to cure them. Even if they get better in the end, it is often only after a serious injury has happened to their body or constitution beyond the skill of man to repair.

Laws are passed also to prevent too many people living in one room, for that is a great cause of ill health; and to forbid young children from working in factories, which prevents them from growing up healthy; and to limit the number of hours that any person may be compelled to work, because the confinement and fatigue undermine health. Many countries and States also do all they can to induce or compel people to take proper precautions even to protect themselves from infectious diseases.

WHAT THE AMERICAN GOVERNMENT IS DOING TO CHECK DISEASE IN PANAMA.

You have all heard about the Panama canal which is being cut through the Isthmus of Panama from the Atlantic to the Pacific ocean, to make a way for big ships to go from one ocean to the other. But perhaps you do not know that a number of years ago the French tried to make that canal, but had to give it up. Do you know why they failed? It was chiefly because Panama was such an unhealthy place that the workmen died off from fever at a fearful rate. It was not then known how that deadly fever was spread. But now we know that it is carried by mosquitoes, which first bite a person sick with the fever and take up the poison from his blood; then, when they bite a healthy person, they introduce some of the poison into him, so that he becomes sick himself, and so it spreads from one to another. Now the United States Government sent out to Panama Colonel Gorgas, a doctor from the Medical Corps of the United States Army, who had already cleared Havana of the deadly yellow fever that used to kill thousands of people a year. Colonel Gorgas made all the people live in screened houses and screened all the sick, and killed off all the mosquitoes so far as possible by draining or recovering with coal oil all swamps and other places where mosquitoes breed. Six years later the death rate of Panama was lower than that of the city of New York. There were only forty-five deaths out of forty-three thousand people. And now the Isthmus of Panama has no more malaria or yellow fever, and the climate is healthful and strengthening, agriculture is developing, and there is no more sickness there than in any ordinarily healthy country. And under the government of the United States a like improvement is taking place also in the Philippines, formerly a very unhealthy country.

DISEASES WHICH AFFECT ANIMALS.

But man is not the only animal that suffers from diseases. Hogs suffer from hog cholera; horses from glanders; cattle from foot and mouth disease; chickens from chicken cholera; sheep from ''fluke'' or sheep rot; mice from septicæmia; rats and ground squirrels (and other rodents probably) from plague. Some of the diseases in human beings attack animals also and vice versa. Anthrax, or wool sorters' disease, comes to man from the fleece of diseased sheep. Tuberculosis, or consumption, is very common in cattle, and guinea pigs and monkeys are very easily affected by it. Glanders, a disease of the horse, attacks man also. Plague is carried to man by fleas from diseased rats. Cowpox is smallpox modified and made mild on being caught by the cow from human beings. Tetanus, or lock-jaw, affects horses and men. Dogs as well as men suffer from tapeworm. Pneumonia is a very fatal disease in cattle.

SOME DISEASES ARE SPREAD BY ANIMALS.

For instance tuberculosis is spread by the milk of tuberculous cows, and some think by their flesh, too. Trichinosis, or muscle worm, is sometimes taken by man from eating insufficiently cooked pork, as in Germany where it used to be common. Diseases of this kind are getting less common nowadays because we now know that the minute living beings that cause them are killed by great heat, such as is used in cooking. Cats and other pet animals often help to carry diphtheria. Certain kinds of mosquitoes, as has been stated, spread malaria and yellow fever. In like manner ticks spread spotted fever, and flies typhoid.

BUT PLANTS MAY HAVE DISEASE THE SAME AS ANIMALS.

There are diseases of plants, just as there are diseases of animals. Among these are the potato disease, the ''smut'' that affects barley, wheat, oats, and Indian corn; ''bladder'' or ''pocker plum''; hop mildew and grape mildew; ''fingers and toes'' or ''club root,'' which attack the roots of cabbages, turnips, brocoli, cauliflower, and other plants of the same order. All these diseases are due to the attack of a particular kind of microscopical fungus which fixes itself to some part of a living plant, and extracts from it those food materials which it is unable to manufacture for itself, as the plant does, from the air under the influence of sunlight.

HOW DO DISEASES AFFECT THE LIFE AND GROWTH OF PLANTS?

Diseased plants become pale and ''wilt,'' or wither; or they may become discolored and spotted and pulpy, as in potato disease. Sometimes mould threads are seen on them, ''smutted'' wheat is withered and full of a black powder. Or growths and swelling may appear as in the oak gall which is caused by an insect. The fungi enter into the breathing spaces between the cells in the plant, thus preventing the aeration of the cells and the exchange of carbonic acid gas, oxygen, and watery vapor between the cells and the atmosphere, devouring the oxygen and the water and robbing the plant of the food it had prepared for itself and stored up.

THE CAUSES OF DISEASE IN PLANTS AND ANIMALS.

Diseases, whether of plants or animals may be due (1) to inborn delicacy or weakness; (2) to unsuitable surroundings, as when plants are in too wet or too dry soil; (3) to poisons, either manufactured in the course of the life processes or introduced from without; (4) to infection, that is, to the introduction into the body of minute animal or vegetable beings that live in the blood or the tissues of which the body is made, and grow therein, poisoning it by their own life products; (5) to parasites, that is, living things such as lice, which infest the surface of the body, or worms which take up their abode in the digestive tubing, the mouth, stomach, and bowels. You have been told about the bleeder's disease; that is an instance of the first kind. Causes of the second kind are insufficient light or air, or impure air, as when people are overcrowded, or too great or too little pressure of air. The air at the sea level presses on the body with a weight of fifteen pounds to each square inch. The pressure is much less than that on high mountains, so that many people suffer distress in breathing, bleeding from the nose, etc., at a great height. On the other hand, people who go down in diving bells are subject to a much greater pressure under water, and if they return to the surface suddenly they also suffer, as in the disease known amongst divers as "caisson disease." The third kind of disease is shown in the weariness and headache and general distress that we suffer when our functions are not working properly and the poisons that are formed during the life changes in the body are not got rid of through the breath, the perspiration, and by the movements of the bowels and the urine. Workers in lead often suffer from paralysis and colic; various poisons, such as arsenic, mercury, phosphorus, copper, etc., cause illness in those exposed for a long time to their action, as also does the escape of illuminating gas. Ptomaine poisoning belongs to this class also. You have heard of people becoming ill from eating oysters and other shell fish, bad meat or fish, "spoiled" corn, decayed cheese, bad milk, etc. The use of alcoholic drinks in excess also sets up disease. The fourth form of disease, by infection, is by far the most important, and more and more we are learning to put in this class many diseases that were formerly thought to be due to totally different causes. Of the small animal organisms that cause disease, must be especially mentioned the small jelly-like beings called protozoa, such as the plasmodium malariæ that get into the blood through mosquito bites and cause the various kinds of malarial fevers. The vegetable disease "germs," called bacteria, will be spoken of later. Finally there are body and head lice which infest the surface of the body, and tapeworms, roundworms, thread, seat, or pinworms which inhabit the digestive tube and cause disease. But it must be remembered that nearly always, besides the infecting agent or germ, there must be a weakened condition of the body, either inherited or acquired from bad habits, unhealthy surroundings, lack of cleanliness or improper food, to enable the germs to flourish in our bodies, just as seed would not grow if planted on a rock. We are probably all of us breathing or taking in disease germs in our food all the time; but so long as we are in good health and keep ourselves clean, and are moderate in our habits, and get plenty of pure air and exercise, and have enough nourishment they can not settle in us and multiply sufficiently to do us harm, unless we take in a very large number of them, and they are strong and healthy enough to resist the natural tendency of our bodies to get rid of them or render them harmless. So that it is *very important that you should endeavor to keep your bodies at all times in as sound a condition of health as possible,* and then you will be much less likely to "catch" any infectious disease when you are exposed to infection by coming into close contact with those affected.

DISEASES IN HUMAN BEINGS CAUSED BY POISONOUS PLANTS.

You have all heard of hay fever. That is a disease caused by inhaling the pollen or seed dust of various plants, principally certain kind of grasses. You are probably familiar too with the effects of poison oak or poison ivy, which causes a very irritating rash and swelling of the skin. Mushrooms when eaten sometimes cause severe nettlerash. Sprouted potatoes are dangerous food, as they occasionally cause poisoning also. A disease affects the rye plant sometimes, and in countries where rye is much used as a food there used to be epidemics of ''ergotism.'' Finally ''pellagra,'' of which a good deal has appeared in the papers of late years because it has been found prevalent in certain parts of the United States, has been attributed to eating what is called ''spoiled'' corn.

DISEASES CAUSED BY MINUTE VEGETABLE ORGANISMS CALLED BACTERIA.

Bacteria are very minute living vegetables, so small that they require a very powerful microscope to see them. Even then they are hardly visible unless they are stained by certain dyes. They are found in three forms: short rods (bacteria), corkscrew spirals (spirilla), and little round balls (cocci). There are innumerable varieties of them, most of which are harmless for man. We have myriads of them in the contents of the bowels, where they serve a useful purpose in splitting up the waste material into its most elementary form. The action of certain bacteria is useful in making vinegar and in tanning leather, in curing tobacco, in making flax for linen, and in many other ways; but they also do harm, spoiling meat and turning milk sour, rotting woodwork in the ground, spoiling fruit and hay, and so on. But worst of all, a few varieties of them prefer the human body to grow in, and these cause various diseases, and it is with these that we are particularly concerned. The most remarkable thing about bacteria is the rapidity of their growth. They multiply by just splitting in two, and this splitting goes on at such a rate under favorable conditions that one bacterium may split up into sixteen and a half millions in twenty-four hours. Fortunately Nature puts a limit to their reproduction, for in a limited space they exhaust their food supply or poison themselves with their own excretions; otherwise we should all be eaten up by them. The human body defends itself against their attacks in two ways, first by the little white cells of the blood, which attack them and swallow them up; and secondly, by manufacturing special substances in the blood which seize hold of the poisons manufactured by the bacteria and render them harmless. It is in this way that, in most of the "infectious" diseases, one attack protects, for a while at least, against a second. For if the body is healthy and resistant, very many more of these protective bodies are formed than are required for immediate use, and these remain in the blood, ready to seize on any fresh invaders. This is what is meant by diphtheria antitoxin of which you have all heard. It consists of the watery part (serum) of a horse's blood which has been gradually accustomed to the diphtheria germ by repeated injections of it. The blood of such an animal is abundantly supplied with these protective bodies, and when the serum is injected into a human being infected with the disease or in danger of being infected, it adds its own defensive bodies to those of that person. It is just as though two nations being at war, a third nation should send a lot of its soldiers to help the nation that was being attacked.

Now, different kinds of bacteria give rise in the human body to different diseases. There is a tetanus bacillus which causes tetanus, of which ''lock-jaw'' is the best known form; the tuberculosis bacillus, which causes consumption; the diphtheria bacillus, which causes diphtheria; the influenza bacillus, which causes ''grippe''; the ''comma'' bacillus of cholera, so called because it resembles a comma in shape; the typhoid bacillus which causes typhoid fever; the bacillus of plague, which is killing so many people in the Orient all the time, and which was the cause of the great epidemics of plague in the Middle Ages in Europe. Pneumonia is caused by the little round bacteria, called pneumococci. Other cocci, the streptococci, or chain cocci, and the staphylococci, or grape-bunch cocci (so called from the shapes in which they group themselves), cause blood poisoning after wounds, and are at work wherever ''matter,'' or pus, is formed. Other cocci affect the membranes that cover the brain and spinal cord, and cause the terrible disease, cerebrospinal meningitis, for which an American physician, Doctor Flexner, has recently found a curative serum in a similar way to that already described in regard to diphtheria antitoxin.

Now when people have any of these diseases the bacteria are shed by them in their discharges from the bowels or the urine or the skin or the expectoration, and fall around everywhere and become attached to dust and food, or are carried about by flies and so we take them into our bodies, either by breathing or with our food, or in other ways, and they at once begin to act upon us. The white cells of our blood, called leucocytes or phagocytes (that is, white cells or eating cells) immediately endeavor to eat them all, and there is a real battle fought in our bodies. If our white cells are numerous enough and strong enough they win the day, and that is what is happening most of the time, otherwise there would be a great deal more infectious illness than there is; but if we have let ourselves run down in health by lack of cleanliness and exercise, by living crowded together and in insufficiently ventilated air, by insufficient or improper food, by bad and unhealthy habits, etc., then our phagocytes are not able to fight successfully with the invaders, which continue to grow and multiply in our bodies, and in so doing throw out special poisons which cause disease. So you see how very necessary it is always to keep ourselves in good health that we may be able to resist these disease-inducing germs, which are present all around us and are constantly being taken into our systems.

CHAPTER XIV.

Food, the Essential of All Life.

EVERYTHING WHICH HAS LIFE REQUIRES FOOD.

FOOD is a requirement of everything, plant or animal, which has life. It is not the only requirement for life requires air, water, rest, sleep, and various other things, but to keep up its nutrition, to continue its power to grow and do work of whatever kind, it must have food.

Food therefore is any substance or material which helps to furnish nutrition to any living object. The plan and arrangement of the world have been such that food in some form or other can usually be obtained wherever there is life to be sustained and nourished. Not all parts of the world are equally fruitful in providing food, nor is it necessary that they should be, for life in some regions is much more abundant than in others. Furthermore, some portions of the world which have seemed entirely unsuitable to furnish anything that would sustain life have been made fruitful as knowledge has increased and men have learned to meet and overcome certain conditions which have heretofore prevented the presence of food material. Take for example a desert which seems to be nothing more than a sea of sand. We know that in many deserts there are wonderfully fertile spots called oases, which yield food in great abundance. Now it is fair to presume that at some time or other these oases were as barren and free from food as the country which surrounds them, but in some way the unfavorable conditions have been overcome and the Bible statement that "the desert shall blossom as the rose" has become literally true.

In large tracts of the United States there existed land which was supposed to be utterly worthless at least so far as furnishing food was concerned. But some one conceived the idea that if it were supplied with the proper amount of moisture, in addition to the great supply of heat which it already had it could be made useful and productive, and then followed the whole grand scheme of irrigation upon which the government and numerous individuals have expended many millions of dollars with the result that the land which was formerly dry and useless now abounds in beautiful gardens and orchards and yields food in the greatest abundance. Furthermore there is much land which is wet and swampy and which has more moisture than it requires or can use to advantage. Such land yields little which is useful for food. But when this land is drained, and soil is added to it, which is being done in many places, we at once get a basis for abundant harvests. But the earth or the soil is by no means the only source of food, the water yields far greater crops than the land. It seems scarcely possible that water which is almost as cold as ice could contain such an abundance of food, both animal and vegetable. But so it is, the soil beneath the water produces life and food supply in the form of thousands of varieties of plants, the water itself holds in solution great stores of animal and vegetable material, while within it swim the countless myriads of fish which supply food for men and animals. Upon the coast of Norway the shoals of codfish are sometimes so numerous that they form almost a solid mass in the water. The same is true of the salmon in some of the rivers which empty into the Pacific ocean, and each one of these fish which is a supply of food in itself must have had the necessary food to enable it to live and grow, which was supplied from the inexhaustible storehouse of the ocean. Earth and water are not the only sources of food, the air by which we are surrounded is filled with material which will sustain and nourish some kind of life.

It may be the seeds and leaves and dust of plants which the wind blows from place to place, it may be minute forms of animal life too small to be seen with the naked eye, or it may be insects and birds which in some places and at some times are so abundant as to prove a nuisance, or even a pestilence. Think of the swarms of mosquitoes, locusts, and other insects which sometimes come down upon a community. They all require food to sustain life and when they yield up life they become food for other forms of life. You have probably heard of the great swarms of pigeons which used to visit the southern and western portions of the United States, shutting out the light of the sun by their numbers, when they were in flight. The Bible tells us that soon after the Hebrews left Egypt they were visited by a swarm of quails so great that food was supplied by this means for days to the hundreds of thousands of these wanderers who had been crying to God for meat.

Not only do the earth, the air, and the water contain the elements of food for both animals and plants, but another interesting fact which may have occurred to you as we have progressed in our story is that life sustains life, and if we begin at the lowest forms in the scale and work upward we see the unvarying application of this law. The plants are nourished by the dead and decomposed bodies of other plants. Some plants are even nourished by the bodies of animals. There is quite a large family of such plants of which the pitcher plant which grows in swamps is a good illustration. This plant has a cavity like a cup or pitcher which will hold a couple of tablespoonfuls of water which it absorbs from the soil or gathers from the dew and rain. In this fluid insects are often caught, drowned, and dissolved and thus changed into food for the plant. Birds derive much of their food from insects, snakes from toads, frogs, rabbits, etc. No doubt you may have seen a toad catch a fly and then wink as if he enjoyed it. Many kinds of fish live upon other fish. I have seen a pickerel with five or six good-sized suckers in its stomach.

Many animals even eat their own young which seems a great perversion of nature. Certain varieties of animals are classified according to the kind of food which they habitually eat or the way in which they eat it; thus the *herbivora* are the animals which eat plants or vegetables, or grain, like cows, sheep, horses; the *carnivora* are those whose food is principally flesh or meat, like cats, dogs, lions, tigers and many other wild animals; the *rodents* are the animals which gnaw their food with their sharp front teeth, like squirrels, rats, and mice; *omnivora* are those which eat animal or vegetable food or both, according as they are able to get it and include apes, monkeys, and human beings. Human beings use food of all kinds, and this depends with many, as we have said, upon what they may be able to get. There are some who are obliged to live upon animal food because almost nothing else can be obtained, like the Eskimos in the far North. There are others who live almost entirely upon vegetable food, partly because it is the custom of the country, and partly because, for various reasons, they could not get animal food if they wanted it.

Did you ever hear of human beings who ate the flesh of other human beings? There are many of that kind of people in the world, though fewer than there used to be when more people than now were savages and lived in the woods, rather than in villages and cities. Such people are called cannibals. Travelers in Central Africa tell us of many native tribes there which cling to this degrading habit. When we think of the habits of many of the animals which feed not merely upon animals of other kinds but upon those of their own variety, and even upon their brothers and sisters and children, it does not seem so very strange that savages who, though they have the possibility of more or less intellectual development, are on a level with wild animals in their habits and appetites, should be like the animals in their selection of food. Besides we must remember that the materials of which a human body is composed are the same as those of the animals which supply us with food. You may have read stories of men who were ship-wrecked, and who killed and at one or more of their number when all other sources of food were exhausted. In some places, the people, either from necessity or choice, eat dogs and cats, and horses and rats and mice. It is the influence of the mind alone which prevents men from being cannibals like the savages of Central Africa. Bring one of these savages to a country where there are other varieties of food, and where cannibalism is not fashionable, and he would have very little opportunity and perhaps very little desire to eat human flesh. And so it would seem to be evident that custom, or the common habit regulates the materials which we use for food as it does the cut of our clothes and the way we dress our hair.

THE BETTER THE FOOD SUPPLY THE BETTER THE RESULT IN HEALTH.

The object of food is, as we have stated, to sustain life, to give nourishment to enable animals and plants to grow and do the work which each may have to perform. Minerals do not require food because they have no life to sustain and this may be considered the fundamental difference between minerals on the one hand and animals and plants on the other.

Sustaining life means supplying the cells, of which all the tissues are composed whether in animals or plants, with the substances which they need, minerals to one, albumen to another, sugar to another, fat to another, and these substances, as we have also told you, are delivered to the cells by the blood in its journey over the body, and in a fluid or nearly fluid form. Another object of food is to develop or make heat. A steam engine will not do work unless the boiler contains water and the furnace contains fuel. The fuel must also be of such a kind that it will burn well. There must be fire or combustion, and a good draught, to heat the water which develops the steam, which makes the machinery move, to do the work. What the fuel is to the engine, the food is to the machinery of the body. The heat of the body is something which even a child can appreciate. If it is very much less than 98.4°F. in a human being, that person usually has a feeling of coldness or chilliness, and the surface of the body may also feel cold to the touch. If it is very much above that figure there is often, though not always, a feeling of uncomfortable heat. You have often heard people say that they feel cold as ice, or they feel as if they were burning up. This means that there is something wrong in the heat-producing apparatus, and very often the fault is traceable to the food. Food may therefore be good or bad, useful or injurious. But you will probably ask me what is meant by these terms and how you are to tell the difference. This is a perfectly fair question, because the words, good and bad, when relating to food substances, do not always mean the same. Much has been written in recent years concerning the proper food for soil or land. Many portions of the country which have been cultivated or farmed for a very long period no longer yield the crops which they formerly yielded, and so the people have moved away because the soil would not give them a satisfactory living. But those who have studied the subject have found that if the land were properly cultivated and fed with a sufficient quantity of substances containing nitrogen, and if after this the proper kind of seed were planted the soil would again become as fruitful and productive as ever. In other words the soil was worn out because it was worked too hard and did not receive the proper kind of food.

Nitrogen or substances containing nitrogen would be good for such soil while substances which did not contain a sufficient amount of nitrogen would be bad food, almost as bad as giving the soil no food at all, which is the habit of some farmers who are lazy, or ignorant, or both. But on the other hand, in some more recently settled sections the soil is so rich in nitrogen already that if substances containing nitrogen were added to it we would be giving it bad food, because it does not need it, any more than a pail which is full of water needs any additional water.

If you were to place a nice fresh beef-bone before a horse, no matter how hungry he might be he would not eat it. Why? Because he is one of the herb or grass-eating animals, but if you place before him a bunch of fragrant hay, he will begin to eat it at once, and perhaps tell you by his looks that he now has good food, and food which will enable him to do work for you. If now you were to take the bone which the horse refused, and hand it to a dog, he would seize it at once and begin eating it with the greatest relish. If instead of the bone you had offered him some of the same kind of hay which the horse was enjoying he would not touch it. That which was good food for the horse was bad food for the dog.

What is true as to good food and bad food for plants and animals is equally true for human beings. When the Japanese army was in Manchuria, a few years ago, fighting against the Russians, the soldiers were at first fed almost entirely upon rice. Soon they began to suffer with various diseases and their quick-witted surgeons promptly made up their minds that the fault was in the food. They were getting plenty of starchy food but none of the albumenoids. So they added to the daily ration of each soldier a small quantity of dried fish and very soon the diseases disappeared. During the remainder of the war the army suffered little from disease, and it was largely owing to the fact that the soldiers had suitable food that they were able to fight successfully some of the most terrible battles in the entire history of warfare. The trouble was not that the rice was not good food, for it was food to which they were accustomed at home, but that the extra strain which was put upon them in marching and fighting, and the unusual exposure of army life demanded albuminous food which is always necessary when such hard work as soldiering and campaigning is to be done. We see from this illustration also that it is not always or only the quantity of food which is to be considered in making up the daily bill of fare.

It has been found by experiment upon large numbers of men under different conditions that they can live for a certain length of time upon almost any kind of food, that they will not be able to do good work continuously upon any one kind of food, and that they will thrive best and make the best output of work upon a mixed diet. If such a diet were divided into twenty-six parts, fifteen of them would consist of water, five of lean meat, five of bread, and one of fat or butter. This is the simplest form of diet that could be selected and it would be sufficient to support life under ordinary conditions and enable one to do a fair amount of work. The weight of this quantity of food should be water three pints, meat fourteen ounces, bread seventeen ounces, and butter three ounces. A diet like this, day after day, would become very monotonous, and while it has to suffice for the very poor, those whose means will permit are very apt to partake of more or fewer food substances in addition to those mentioned.

SOME VALUABLE FOODS.

Milk is an article of food which is and should be universally used, since it contains all the elements which are necessary to nourish the body and sustain life. In one hundred parts of good milk there are eighty-six of water, four of albumenoids — in the cheese, five of sugar, three and a half of fat—in the butter, one and a half in the mineral salts. Oatmeal is a valuable food and contains all the elements which are necessary to produce good results in heat and work. There are no hardier or more useful people in the world than the Scotch, many of whom use oatmeal as the principal article of food. Rice consists mostly of starch and should not be used continuously at more than one meal a day. Eggs contain all the necessary elements of food, as we would naturally expect, for they constitute all the food which a developing bird can get. In one hundred parts of egg there are sixty-five of water, one and a half of salts, fifteen of fat, and eighteen of albumen. Potatoes contain all the necessary elements, but they have too much starch and too little albumen for an exclusive diet.

White beans and peas contain twice as much starch as albumen, but make an excellent combination with other substances. Pork and beans furnish a very satisfactory diet for the severe labor of certain forms of out-of-door life. In many of the lumber camps they form the chief article of diet for the hard working lumbermen. Other vegetables contain starch in abundance, and some of them contain an abundance of sugar also. Juicy fruits are not very nutritious but they are agreeable to the taste on account of the abundance of sugar and vegetable acids and salts which they contain. The necessary mineral element of the food is contained in most of the substances which we eat, and almost everybody is accustomed to add to his food chloride of sodium or common salt which is one of the most abundant of all the mineral elements of the body. Most kinds of food, whether animal or vegetable, are not only more agreeable to the palate when eaten fresh, but are also more healthful. Some people say they are fond of "gamey" food, that is of meat which has begun to decompose, but they run no little risk of poisoning in eating such food. Fish of all kinds, particularly, should never be eaten except when fresh or properly preserved. Poisons of a very virulent nature develop in such food very quickly after it has begun to decompose. Ptomaine poisoning, that is poisoning which is due to the development of germs called ptomaines, is very often produced by such food, and as it develops very rapidly, causes great discomfort, may last for a long time, and may have a fatal result, we should avoid, by all possible means the use of food which may produce such results.

RAW AND COOKED FOODS.

Should we eat our foods raw or cooked? The animals of course never cook their food, and in most cases they are probably satisfied with animal or vegetable food in its natural condition. Human beings also eat many kinds of food, animal as well as vegetable, in a raw state. This is perfectly proper if we are sure that the food is fresh and clean, and free from any harmful substances. But on the other hand many kinds of food are not only more agreeable to the taste when cooked, for cooking brings out a flavor which the raw food does not possess, but they are also, in many cases, more easily digested after they have been cooked. This is particularly the case with the starchy foods, peas, beans, potatoes, etc., which contain much indigestible material, and are not suitable for food until they have been thoroughly cooked. On the other hand vegetables like lettuce, radishes, cresses, cabbage, etc., are more easily digested when they are eaten raw. In any case when preparing food, the question should not be first of all, is the food pleasant to the taste, but is it of such a character that the digestive machinery can properly dispose of it, and convert it into heat and nourishment.

AN IMPORTANT QUESTION.

The food question is perhaps the most important that human beings have to face. Countries have been deprived of their population because the soil was not fruitful enough to support them. At the present time hundreds of thousands of human beings, and some writers say more than a million die from starvation every year in India. And every year a large number of persons die from hunger in China. This is partly due to bad government, partly to ignorance, partly to uncontrollable conditions. The possibilities of food supply are so great, throughout the world, the means of producing food so much more ample than they used to be, and the ability to purchase food in abundance is in the hands of so many that there seems little excuse that anybody should go hungry, to say nothing about dying of hunger. If only the greed, and the selfishness, and the forgetfulness of the wants of our fellow creatures could be overcome or conquered or destroyed men and women and children would no longer be hungry, and naked, and miserable.

CHAPTER XV.

Five Very Important Food Substances.

OF all the food substances which are taken into the body, five—albumen, starch, sugar, fat, and alcohol—are the most abundant, and the most important, water alone excepted. Because they are so important we would like to tell you a little more about them than has already been told. The most important of all of them is *albumen,* for the largest portion of the tissues of the body is composed of this substance, it is a constant and very important element of the blood, and its loss from the body in its soluble form, when it is removed from the blood with the urine is always an indication of disease.

The supply of albuminous food in nature is abundant, and, by proper scientific methods, can be increased to any desired extent. How quickly when a new variety of animals is introduced into a country they can be increased by careful breeding and other precautions to an enormous degree. The millions of cattle which roam over the western ranges of the United States have been there but a few years. Within the memory of many who are now living they have taken the place of the buffalo which were once as abundant as the cattle are now, but have almost disappeared from the face of the earth. In the far northern wilds of Alaska the reindeer were introduced but yesterday, and if reports are true they have already multiplied so as to add greatly to the stock of food. Rabbits had increased to such a degree in Australia a few years ago that it became necessary for the government to take measures to destroy them though they were valuable for food. Almost any kind of animal could be used for food in case of necessity, and we know very well that when the food supply is scanty and famine is present people will eat all kinds of animals which they would not do when they could have such food as they might choose. We have told you of the vast shoals of fish which swim in the seas, and though they form the food supply for millions upon millions of people the supply seems inexhaustible. There seems to be no considerable portion of earth, air, or water from which a supply of albuminous food may not be drawn. If meat or the flesh of animals is the most common form of albuminous food in the world, the form which is probably next in abundance is eggs, and it is more familiar to people in general as albuminous food than is meat. The supply of eggs, like the supply of meat could be increased indefinitely if it were necessary, for it would be possible to domesticate many more varieties of wild fowl, than have thus far been domesticated, and utilize their producing power, which is always in excess of the requirements of reproduction. Next in importance as an albuminous food is milk which also contains all the other elements which are necessary to make a perfect food.

Important as albumen is, it would not be well to attempt to live upon it. There are people whose place of residence is such that they can get little but albuminous food, or such food at any rate as is derived from animal life, for they live where there is little or no vegetable life. While those who live in very cold climates must have an unusual proportion of albuminous food, there is no doubt that their physical condition would be improved if a suitable quantity of starchy food could be added. The albuminous food which is taken into the body is digested in the stomach and small intestines. As it is often combined with hard and undigestible material of other kinds, some of it may pass through the intestinal canal without undergoing much change, but the larger portion of it is dissolved and converted into a fluid and then absorbed into the blood to form its store of blood albumen.

The different forms of albumen which have been considered are those which are derived entirely from animals. Albumen may also be obtained from plants and vegetables but it is not sufficiently abundant in them to enable one to live satisfactorily upon an exclusively vegetable diet. In peas and beans, in wheat, and in many juicy vegetables there is a substance which is called vegetable albumen. In wheat flour it is known as *gluten,* and because wheat possesses this as well as other necessary elements the bread from which it is made is often spoken of as the "staff of life."

STARCH IN FOOD.

As we have already seen in a previous chapter, *starch* is one of the most plentiful things in the world and it is one which is produced only by plants or vegetables—minerals do not produce it, neither do animals. It is the result of life in all growing plants. The plants do not get it, as a whole, out of the ground nor out of the air, but they take materials from the ground and the air and change them in the laboratory or machine shop which belongs to each plant into starch. These materials are carbonic acid and water and when they are acted upon by the proper amount of sunlight and heat starch is produced in the plant, while at the same time the plant gives out oxygen to the air. It thus becomes a part of the body of the plant as the bones and muscles are parts of the bodies of animals. As albumen forms a large portion of the structure of animals, so starch forms a large portion of the structure of plants. The albumen in animals becomes a foodstuff for human beings and so does the starch in plants. No plant is composed entirely of starch just as no animal is composed entirely of albumen. That is the reason why we do not eat all portions of many of the plants which are used as articles of food. It may be interesting to know how much starch there is in some of the plants which we are accustomed to eat. In rice nearly nine-tenths are starch, in wheat, rye, oats, barley and corn there are from six to seven-tenths; in potatoes, peas and beans, there are from two to four-tenths. These are the principal vegetables or plants which human beings use for food. Of course there are many others, and the quantity of starch which they contain varies.

The starch in plants is deposited mainly in the seeds and roots where it acts as a reserve or storage supply which if not taken by human beings for food will be used for the nourishment of other plants, which, like children, may grow from those seeds or roots. Thus potatoes, grains of corn, peas, beans, etc., which are planted in the ground and which begin to live when they have been placed under the proper influence of heat, light, and moisture have this supply of starch (which, however, is first dissolved and changed to sugar) for their nourishment during the first period of growth, just as the bird in the egg has the albumen of the egg for its food until it comes out of the shell.

Though starch is so necessary and so useful as an article of food it has been found that most people, in America at least, can not do their best work, if they have nothing else to eat. It is true that a very large portion of the human race live principally upon rice. There are probably hundreds of thousands and perhaps millions of the Chinese, Hindus, and other natives of Asia and Africa who never have anything else and are glad to get that. But in temperate and cold climates everywhere a diet of pure starch would be insufficient to provide suitable nourishment. Some animals can and do live entirely upon starchy foods, but you must remember that the grain and plants upon which animals feed contain other things in addition to starch, and therefore they get variety to their food in that way. Animals have been fed experimentally upon pure starch with the result that they soon become weak and emaciated, thus showing that they, like human beings, can not live and thrive upon one substance alone. In addition to being a necessary article of food starch is also useful for a variety of other purposes. We would hardly know how to do without it in the work of the laundry, and it is also very useful as a paste or glue to painters, paper-hangers, bill-posters, and workers in many other occupations.

One of the most remarkable things about starch as a food is that it is not used as a food in the form of starch either by plants or animals. In plants it is first dissolved and changed into sugar before it can be used. In the early spring the sap begins to flow in the trees. This sap we frequently draw out from maple trees, and after it has been boiled sufficiently it becomes the delicious maple sugar with which every boy and girl is familiar. This sugar is merely the starch which was in the roots of the trees which was dissolved and changed that it might furnish the tree with nourishment. In like manner the starch which we eat in our vegetables is changed into sugar, first by the pytaline of the saliva, when we chew our food, and second when it reaches the small intestine, and is mixed with the juice from the pancreas. Starch as an article of food is therefore a substance which must undergo suitable chemical change before it can be assimilated or used by the body.

SOMETHING WE CAN NOT LIVE WITHOUT.

We have just told you how sugar was obtained and that it was one of the substances which the body can not do without. Though the body is constantly making it out of the great variety of starchy foods which we are eating every day with our meals, and though the liver is a laboratory in which a peculiar kind of sugar is constantly being made and stored up and sent out again as it is required, we also take large quantities of sugar ready made into our bodies. Before an infant is born into the world the sugar-making process is going on in his liver, and when he comes into the world the only food (milk) which he gets for a long time has sugar as one of its principal ingredients. When the teeth appear and he no longer lives on fluid food, he still wants an occasional lump of sugar or a piece of candy, or a portion of sugar in the various substances which he eats. This sugar-eating habit is kept up to the end of his life, and while there frequently is danger of eating too much of this substance and many people take more than they require and suffer with indigestion, in consequence, it is not wise to do as some parents are in the habit of doing—withhold sugar entirely from their children for fear, as they say, that it may injure their teeth.

Is it not interesting to find in this requirement of the animal body another point of resemblance to the plants, for they, like animals, can not live without sugar. They also get their sugar from starch which has been transformed; human beings get it in that way and they also get it, as we have said, in the ready-made form. It seems to be another link, however remote, in the chain by which all living things are united.

I suppose you may have wondered why it is that almost everybody likes sugar. The most apparent reason is that it is sweet, that is, it is agreeable to the sense of taste. Because it is a necessity for the body is perhaps one reason why it has such an attractive taste. Very few people would think of eating bitter or sour or bad-smelling substances as they eat sugar, and such substances are not required for the uses of the body every day in the year, as is sugar. It is the sugar in most fruits which makes them so delicious, and however beautiful they may be to the eye, if they lack sweetness we soon get all we want of them.

I have told you there were three principal varieties of sugar, the first being glucose or grape sugar, which is the kind found in the juices of many plants and in the juices or fluids of the body. Liver sugar or glycogen might be considered a variety of glucose for it is made from it and is made only in the liver of animals. Lactose or milk sugar is the second variety and is found only in milk. Saccharose or cane sugar is the third and is obtained from the sugar cane, beet root, sugar maple and various other trees and vegetables. It is the sweetest of the three varieties, grape sugar coming next, and milk sugar last. It may be interesting for you to know that sweet substances can be made chemically in the laboratory. One such substance was first made in the laboratory of the Johns Hopkins University in 1887 from coal tar, and is called *saccharin.* It is three hundred times as sweet as cane sugar, and of course a very minute portion will do as much sweetening as a large quantity of sugar.

The sugar which is taken into the body or which is the result of transformation from starch is taken into the blood and circulates with it as glucose. It is carried to the liver where it is changed to glycogen, it is then changed back again to glucose as the wants of the body have use for it, and is probably decomposed in its further progress along the blood current. As I have informed you, it is one of the evidences of severe disease when it is present in too great abundance. In such cases the kidneys try to relieve the blood of it, and we find it in greater or less quantity in the urine. Sometimes when the disease is severe it is so abundant that the urine is almost as thick as syrup, and a fatal result in such cases is not usually delayed.

THE IMPORTANT SUBSTANCE OF FAT.

We have already given you in several places considerable information in regard to the substance we call *fat,* but there are yet other facts which are important, especially since it is a sort of first cousin to starch and sugar, which we have just been considering, and a second cousin to albumen.

Fat is abundant in animals, in some of which it forms a layer several inches thick under the skin. Whales are captured principally on account of this thick layer of fat which is stripped from the body, melted at a high temperature, and thus converted into valuable whale oil. Many of the plants contain large quantities of fat. You all know how abundant olive oil is and some of you may have had experience, pleasant or otherwise, with castor oil. If you are fond of nuts you must have noticed what an oily taste some of them have. The peanuts, of which almost every boy and girl is very fond, contain a great deal of oil which is used for lubricating and other purposes. Cottonseed oil is now much used as an article of food, or as a medium in frying food instead of lard.

We said that fat in plants was first cousin to starch. Instead of the starch being principally changed into sugar, as is the case in many plants, it is changed in some other plants into oil or fat. Just how this takes place is not clearly understood, nor is it necessary to understand it in order to believe it, for in the plants which yield oil there is starch in the seeds before they are ripe, and when they are ripe the starch has nearly or quite disappeared leaving oil in its place. Does this mean that the starch in these plants is not changed at all into sugar? No, probably not, for the sugar is needed for the life and nutrition of the plant irrespective of the oil which may be produced, but in the oil-bearing plants we do not use their sugar as we do the sugar from fruit trees and maple trees, and beet-roots, but we gather instead their seeds and nuts which yield us oil. Oils are also produced apparently from minerals. When petroleum or kerosene oil was first discovered it was found floating upon the surface of water, for water and oil do not mix readily. We are told that it was used by the Indians as a remedy for bruises and injuries of various kinds. It first received the name of rock-oil, which is exactly the meaning of petroleum, but rock-oil and other so-called mineral oils are usually, if not always, not mineral at all but the result of decomposition of animals and vegetables which lived ages and ages ago. So that we may fairly say that oils and fats are obtained almost if not quite exclusively from animals and plants.

Fat is a very important substance in the human body for it is found not only under the skin where it is our protection from extreme cold, not only in cavities where it serves as a padding and protection to important organs, not only as a means of ornament by giving graceful curves to the outline of the body, but it is also present in those important fluids of the body, the blood, the chyle, and the milk. In these fluids it is found in the form of emulsion, its particles being so fine that they will readily pass through or soak through the different membranes of the body. Perhaps you have never thought or known that the soap which you use, or ought to use several times a day, is obtained from fat, changing into soap being called *saponification.* Either animal or vegetable oils or fats, when in emulsion, can be changed into soap by combining them at great heat with water and a suitable alkali. The chemical change which follows results in soap and glycerine, with which many of you are familiar. How is fat a second cousin to albumen? Because albumen is not usually changed into fat, but there are cases in which the change which is called fatty degeneration takes place, and instead of the muscle which was formerly present in an organ or tissue we find fat. Muscles which are out of use frequently undergo such a change, and it is also sometimes found in the heart, the liver, and other organs. Fat, therefore, is not only taken into the body as a food, but it may be made in the body as a new product, and when thus made it is very often an evidence of disease.

One of the chief purposes in the use of fat as a food is its heat-producing property. For such a purpose it is better adapted for those who live in cold climates than for those who live in temperate or warm climates. Much fat is consumed in its vegetable form in countries where the palm and the olive flourish. Much animal fat is consumed in northern latitudes and in the Arctic regions where the fatty layer under the skin in the animals produces the supply. An exclusive diet of fat would not sustain life indefinitely, and in a temperate climate, especially during the warm season, very little fat is required except by those whose physical labor is severe, and in the open air, and who need its heat-producing effect.

A USEFUL AND A DANGEROUS SUBSTANCE.

We bring the subject of alcohol before you in this connection because it is about as common as the other substances we have just been talking about, moreover it is very intimately connected with two of them, starch and sugar. Without starch, in vegetable life at least, there can be no sugar, and without sugar there can be no alcohol. In other words alcohol, in relation to vegetable life, is the result of fermentation in substances which contain sugar in some form. And what is fermentation? You all know that when bread is made, flour and water are mixed together and form a paste which is called dough. This is not put into the oven at once and baked, but instead a small portion of yeast is placed in it, and it is kept over night in a warm room. In the morning instead of a heavy solid mass of dough we have a light puffy material, which is now ready to go into the oven and be baked into bread. What has taken place? The yeast, which is a kind of plant, under the influence of heat and moisture, and in the presence of the sugar or glucose which was in the dough, has multiplied, its cells growing larger and dividing, thus forming other cells. These cells combine with the glucose which is then split up, as the chemists say, and the parts which remain after the splitting are alcohol and carbonic acid. The quantity of alcohol in such a mass of dough is small and is probably driven off by the heat, after the dough has been placed in the oven. The carbonic acid being a gas, forces its way to every portion of the dough, and that is what causes it to rise. In other words fermentation has taken place.

In the juice which has been squeezed from a quantity of grapes there is also a ferment which acts like yeast. The grape juice is, of course a solution of glucose. As the cells of the ferment in this solution increase they combine with the glucose, the result being the formation of alcohol and carbonic acid in the grape juice. A portion of the carbonic acid escapes and a portion is dissolved in the grape juice, this process being continued as long as any power remains in the ferment. The substance which we now have is called wine and it contains a certain portion of carbonic acid and a certain percentage of alcohol, according to the strength and duration of the fermentation process. We hope the meaning of fermentation is now clear to you. It may take place under certain conditions in any substance or solution which contains sugar and the product will always be carbonic acid and alcohol. You can therefore understand how it is that alcohol is such a common article, and how easy it is to make it from a thousand substances which are all around us. Alcohol may be clear and pure or it may be combined with other substances. In order to get it pure it must undergo a number of processes to separate it from the substances with which it is associated. Different substances contain different quantities of alcohol; the beer and the ale which are in such common use contain from three to ten per cent of alcohol, wines from twelve to twenty-five per cent; whiskey, brandy, gin, etc., from forty to fifty per cent or more.

Now alcohol is a very useful substance, it will dissolve many of the things which we use in every-day life which could not readily be used if they were not dissolved. The painter uses it to dissolve his paints and oils, the chemist uses it in his laboratory, because in burning it he gets much heat, little light, and no smoke, the pharmacist uses it, for most of his drugs would not keep unless they were dissolved in alcohol, the museum curator and workers in animal and vegetable tissues of all kinds use it because it hardens the specimens by combining with the fluids which are in them and keeps them from decomposing. In many other ways it is one of the most useful substances which we have. You all know that in the form of wines and malt and distilled liquors it is one of the most common substances which human beings take into their bodies. As teachers of youth we must set before you the dangers of using alcohol, in any form, as a daily beverage. Its terrible effects when used improperly are too well known to dwell upon them here. The government everywhere realizes the dangers and perils in its use, otherwise it would not require men to take out a license and be subject to police control. So many evils and wickednesses are connected with its use that we are sure, as the result of many years of experience and observation, that young people, without exception, will be better off if they do not use it, as a beverage, in any form.

CHAPTER XVI.

Air, the Most Abundant Thing in the Universe.

WE are living in a sea of air forty to fifty miles deep. Just as important to human beings, just as important to you and me as food, is air. You could live longer without food than you could without air, so that really air is the more important of the two. Is there anything that lives that can do without air? Formerly it was believed to be impossible for either plants or animals to live and thrive unless they had a sufficient volume of air for their necessities. It was not until about the year 1855 that the great French scientist Pasteur discovered that certain forms of very humble plant life, called *bacteria,* could live without the presence of free air. These bacteria, however, were always associated with substances that were decomposing, and as they were broken up, oxygen was set free by them and from them, and this was then taken up by the bacteria. While these bacteria, therefore, can not live without oxygen, they can live without such air as you and we breathe, and hence they are called *anærobic* bacteria, which means bacteria which live without air.

A WONDERFUL THING IS AIR!

Air is the most abundant thing in all the created universe and, so far as we are aware, it is the cheapest and freest. We must pay for water, we must pay for food and for shelter, and for heat, but no one has yet, to our knowledge, had the boldness to try and monopolize the supply of air, and make the people pay for it.

The air surrounds this globe on which we live in a sort of envelope or sea which is forty to fifty miles deep. It has weight like water, or earth, or any other substance. It has elasticity or stretching power, like india-rubber; when it is heated it expands or takes up more room, and when it is cooled it condenses and becomes heavier. The elasticity of the air also has a relation to its pressing power, it presses equally in all directions, downwards, upwards, and sidewise, and that pressure at the sea level, is fifteen pounds upon every square inch of surface. It presses upon every portion of your body at that rate, and the reason why you are not crushed by it is because there is a similar and balancing pressure from the air which is distributed through the interior of your body. Suppose you fasten a sheet very firmly in a doorway. Stand on one side of it with a piece of flat board, two inches square fastened to the palm of your hand. Then get one of your friends to stand on the opposite side of the sheet, with a similar piece of board. Now bring your hands together on the sheet and push toward each other, and let us suppose that each of you pushes with exactly the same force, and that in each case it amounts to sixty pounds, or fifteen pounds to each square inch. As sixty pounds are met by sixty pounds there will be no change in the surface of the sheet. But suppose your friend steps aside, and you continue to push with the same force. The result will be that you will make a dent in the sheet and perhaps break through it. In the same way if the air pressure were removed from the surface of your body, the inside pressure would cause your body to puff out like a balloon, and probably burst some of your blood vessels. The pressure of the air in this vast sea is greater at the level of the ocean than it is higher up. People who live at an elevation of seven or eight thousand feet above the sea level, like those who live in the city of Denver, for example, breathe what is called a rarer atmosphere, that is air which has less density and pressure than it has at the sea level. When one first goes into such atmosphere he is very apt to feel a sense of pressure, he may have headache and dizziness, and if his lungs are weak he may have a hemorrhage, and he will be obliged to breathe faster than he did at the sea level because of the difference in the air pressure. After a while he gets accustomed to the change in the pressure and may have no further trouble in breathing.

WHAT IS THE AIR COMPOSED OF?

Air is a gas, and it has these different qualities which we have mentioned, but it has more than one substance in it. Until a few years ago the chemists used to tell us that in one hundred parts of air there were twenty-one of oxygen and seventy-nine of nitrogen, not closely bound together, but easily separated from each other. Air also contains a varying quantity of carbonic acid, according to the conditions in any given case, a varying quantity of moisture or watery vapor, a little ammonia, and impurities of various kinds. In 1894 a new substance was found in air and because it seemed to have no particular work to do it was called *argon.** The great German scientist Helmholtz lay dying when this discovery was announced to him. Keenly interested in everything pertaining to science, even at the gateway of death he remarked: "I always knew there was something else in air."

The principal elements in air, then, are the oxygen and the nitrogen, and of these two the nitrogen is merely the carrier of the oxygen, and when the two gases are taken into the lungs, in breathing, the nitrogen readily parts company with the oxygen for the latter alone is required for the uses of the body. The nitrogen is exhaled or breathed out, while the oxygen, or a sufficient portion of it, is taken up by the blood in the manner which has been described to you in the different remarks about the lungs.

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*Argon is from two Greek words, one of which means *not*, and the other *work*.

WHERE DOES THE AIR SUPPLY COME FROM?

You are doubtless wondering how the supply of air can hold out, with so many millions of people constantly drawing upon it, and the great army of plants living upon it, also. Human beings use the oxygen of the air. They give back to the air a portion of the oxygen, most of the nitrogen, carbonic acid and watery vapor, and impurities due to decomposition, and where so many are making these contributions the total amount must be large. Plants absorb the air, using the carbon in the carbonic acid for their growth and giving out the oxygen. Plant life furnishes the greater portion of the oxygen which is in the air. The water upon the earth is constantly being evaporated, and this furnishes the air with moisture. The ammonia in the air comes from decomposing substances, while another portion of it is formed by combination of the nitrogen which is in the air with hydrogen which is taken from the watery vapor. The impurities in the air are derived from dust, decomposing animal and vegetable materials, disease germs, the smoke and gases from factories, and the breaking up of the mineral substances on the earth's surface which is constantly going on. The nitrogen in the air is also derived from one or more of the sources just mentioned. Thus we see how many different elements it may contain, and as some of these are not intended for the requirements of the body, it is no wonder that people are often made sick by taking them into their bodies and receiving their poisonous influences.

CAN AIR BE MADE ARTIFICIALLY?

Yes, this can be done very easily. All that is necessary is to take the proper number of parts of oxygen and mix them with the proper number of parts of nitrogen, leaving the argon out because it is of no importance. We know absolutely that twenty-one parts of oxygen mixed with seventy-eight of nitrogen will give us pure air, and if we wished to make it we could take a substance containing oxygen in abundance and another containing nitrogen in abundance, break them up by suitable chemical methods, collect the oxygen and the nitrogen in separate jars, and then allow them to flow into a third jar, in the proportion above mentioned; the gas in this third jar would be pure air.

Nitrogen is often combined by the chemist with oxygen, but not in the above proportion, to form a gas which is called nitrous oxide, and sometimes is called *laughing gas.* If this is inhaled for two or three minutes it will produce sleep, and insensibility to pain, and advantage is often taken of this fact to extract teeth and perform other surgical operations which do not require a great deal of time. Oxygen is also used a great deal for inhalation in certain forms of sickness in which the patient requires more than can be obtained from ordinary air.

WHERE CAN WE GET PURE AIR?

Unless proper precautions are taken we can not get pure air in crowded dwelling houses, in crowded school-rooms, in shops and factories, in churches and theaters. We must go into the open fields, into the forest, or upon the mountain side in order to get air which is free from harmful substances. Many experiments have been made to test the air of different places, and at different elevations. Pasteur, the great French scientist, was one of the first to make such experiments. He ascended a mountain in France, and at different elevations, as he ascended, he collected the air in suitable flasks. Then he took them to his laboratory and examined the contents. He found that the higher he ascended the purer the air became, and that after he had reached a certain number of thousand feet, away from the smoke and dust of factories, away from human habitations he obtained air which was quite pure. This explains why so many people who are sick, and who go to the mountains, after breathing the pure air for a few weeks get well and are able to go to their work again, and also proves what we have said about the importance of breathing pure air, if we wish to keep our health.

WHY DO MANY PEOPLE GET SLEEPY WHEN THEY ARE IN A CROWDED ROOM?

First because they do not get oxygen enough and second because they get too much carbonic acid gas. You will remember that we have told you several times that carbonic acid was one of the substances which you breathe out or exhale from your lungs. If you do not believe it take a tube and blow through it, for two or three minutes, into a glass of water. The water was clear and colorless when you began to blow into it and afterward it became cloudy and milky, and if you took this water to a chemist and asked him to analyze it, he would tell you that the cloudiness was due to the presence of carbonic acid. This is a waste product and more or less poisonous. In the crowded room, whether in a house, a school, a church, or a theater, many lungs are taking in oxygen and giving out carbonic acid. Unless the room is very well ventilated, the oxygen soon becomes insufficient and the carbonic acid too abundant. In a very short time those who are in the room will be breathing more carbonic acid than they can comfortably bear, it will be absorbed into the blood with the oxygen and the blood then having too little oxygen and too much carbonic acid carries a poison which soon produces its effect upon the brain. This is manifested by inattention, yawning, stupidity, and perhaps by sleep. Breathing impure air under these conditions may also produce dizziness, headache, and sometimes nausea and vomiting. If the air is sufficiently impure serious poisoning may result, and even death may occur from suffocation. A well-known example of this fatal influence of bad air is related in connection with the Black Hole at Calcutta. This was a room eighteen feet square in Fort William. On the evening of June 20, 1756, one hundred and forty-six English men and women were shut up in this room. The next morning all but twenty-three of them were dead from suffocation.

HOW DOES BAD AIR DIFFER FROM GOOD AIR AND HOW CAN IT BE PURIFIED?

Good air is that which contains the proper proportion of oxygen, which is one-fifth of its total volume. If the volume of carbonic acid or other impurities is greatly increased the oxygen must also be increased, otherwise one will soon have the uncomfortable feelings which have just been mentioned. Electricity will purify the air. After a thunderstorm you may have noticed how fresh and stimulating the air has become. It is because it has more oxygen than before and very often it contains the very stimulating form of oxygen which is known as *ozone.* Water absorbs impurities from the air, and it is a very good plan to have basins of water or wet cloths in rooms or apartments in which it is particularly necessary to have the air supply pure and wholesome. Especially is this necessary in the sick room. There are certain well-known mineral substances which absorb impurities from the air, and they are of great benefit when the air is charged with bad-smelling odors. Such substances are known as deodorizers and disinfectants. The best and cheapest among them are the chloride of lime, and copperas or sulphate of iron. Such substances when placed in sewers, cess-pools, out-houses, stables, etc., are exceedingly useful by combining with the substances which give out the bad odors and thus preventing their subsequent formation. The most effective way of purifying the air in any kind of a room or building is by the proper application of the principles of ventilation.

WHAT DO WE MEAN BY VENTILATION?

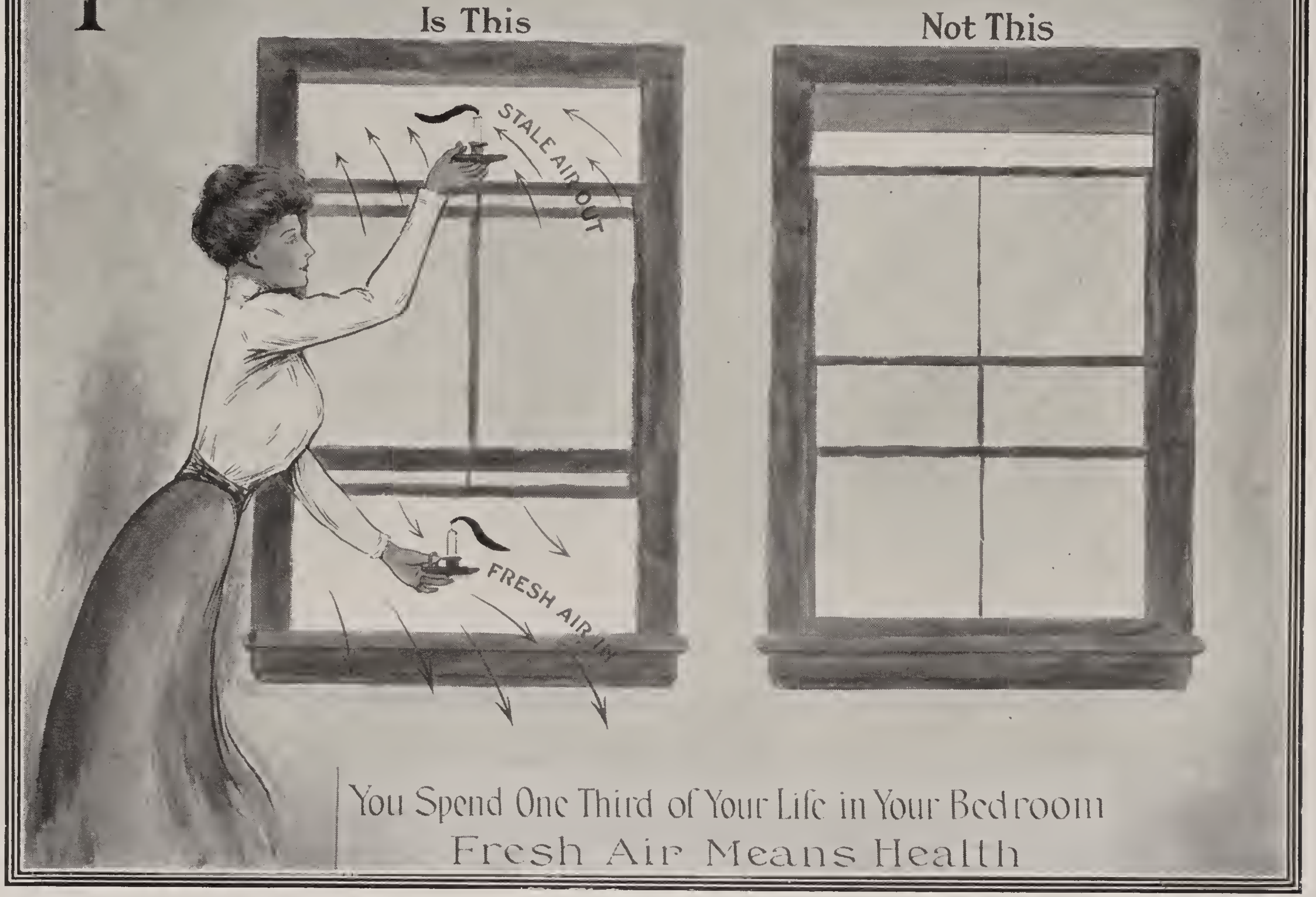
The word goes back in its meaning to the Latin word which means wind, and I suppose the best definition of ventilation would be—supplying with wind. Remember also that those who used the Latin language understood wind to mean air in motion. Therefore it will be easy for you to remember that to ventilate a room means to supply it with air which is in motion. Why should it be in motion? Because in this way it drives or pushes away the air that is in front of it with all the impurities which it may contain, in other words, it makes a draught. Air which is in motion is to be compared with air which is still or stagnant. You will recall how stifling and uncomfortable stagnant air is on a hot summer day when "not a breath is stirring," and when the vigorous use of a palm-leaf fan is very refreshing. The fan does not bring anything to the air, it merely sets it in motion or produces ventilation.

HOW SHOULD HOUSES, SHOPS, SCHOOLS, HALLS, AND OTHER BUILDINGS BE VENTILATED?

Obviously the answer to this question will be—by giving them plenty of air which is in motion. Remember, too, that the question of ventilation applies not only to human beings but to animals, and if our stables and barns are not well ventilated we must not expect that our horses, and cows and sheep and pigs will be strong and healthy. Warm air being lighter than cold is in the upper part of a room. You can easily prove this statement by mounting a step-ladder in a room which is heated by a furnace, and in which lights are burning. Carbonic acid and other impurities are heavier than air and are therefore in the lower part of a room. Where a current of air is admitted to a room, therefore, especially if many people are in the room using its air, the first thing to be done is to force the impure air out, and hence it must sweep through the lower portion of the room. But the overheated air must also be expelled, for hot air is neither agreeable nor healthful, hence a current of fresh air must blow through the top of the room. The best way to keep the air pure is therefore to have a sufficient number of openings at the top and bottom of a room, the fresh air entering upon one side and the bad air escaping on the other. Rooms which are ventilated upon this principle, with openings of sufficient size, will thus be provided with air which is constantly in motion and will be of the proper quality for breathing purposes.

Some trades and occupations are unhealthful on account of the bad air which must be breathed while following them. Perhaps you never realized the risk to health which many people are constantly obliged to take while doing the work by which they get their living. Clerks and salesmen who work in dark and poorly ventilated shops and offices, bakers in overheated bake-shops, factory operatives in rooms which are constantly filled with the dust and dirt from machinery, and the flying particles of animal or vegetable material which are being wrought into manufactured articles, grinders of tools, miners, phosphorus match makers, workers in lead, copper, arsenic, and chemicals of other kinds, these and laborers in many other occupations must take into their air passages substances which do not belong there and which often produce serious illness and shorten life. It is well and hopeful that a righteous public sentiment is being aroused at the wickedness of subjecting human beings to such risk while working for their bread, and we should all demand in the loudest possible tone of voice that all possible safeguard be thrown around those who work in occupations in

The Proper Method of Ventilation



You Spend One Third of Your Life in Your Bedroom

Fresh Air Means Health

which there is danger to life and health. Those who work in tunnels, diving bells and underground passages in compressed air are liable to contract a serious and very painful disease of the spinal cord. Such an occupation can not usually be followed indefinitely, and one can work only a few hours at a time as the day's output.

THE AIR AT SEA AND IN SHIPS.

The air at sea is as pure as air can be, if it were not so those who follow the sailor's life would soon be compelled to abandon it, for the air below the decks in most ships is as bad as the air above the deck is good. Ventilation, except in the expensive and carefully-arranged passenger liners and men-of-war, is about the most imperfect part in the construction of a ship, and it is well that most of the time on shipboard can be spent in the open air. Even in those ships which are constructed in the most careful manner the air in the fire rooms is often so hot, and the ventilation so bad that those who work in them soon get exhausted and must go to the deck to get fresh air.

VENTILATION OF MINES, TUNNELS, ETC.

One of the hardest problems which engineers have to face is the proper ventilation of mines, tunnels, and other underground passages. Have you ever noticed in going into a subway station in New York how oppressive the air is? Except when one is on a moving train in such a place the air is stagnant, and to keep it properly in motion is a problem not yet solved. When to the stagnant air is added the carbonic acid and impurities from the breathing of hundreds of thousands of human beings it is a wonder that the air is not even more sickening than it is. The ventilation of sewers in public streets, and waste pipes in houses, shops, factories, etc., is a matter of great importance. The custom of leading the ventilating tube of waste pipes to the top of a house is both efficient and sanitary, but the ventilation of sewers into the public streets is objectionable and frequently subjects people to the annoyance of disagreeable if not dangerous gases. And so we reach the conclusion that if we desire good health we must have pure air. We may inhale germs of disease in the air of our dwellings, and many of the cases of the dreadful disease called tuberculosis are acquired in that way. We may inhale poisonous gases or particles of dust of various kinds in our occupation. Nature exacts a severe penalty in such cases and ignorance is never accepted as an excuse. To inhale the poisonous illuminating gas from a gas pipe would produce the same fatal result whether it were done accidentally or with suicidal intention.

CHAPTER XVII.

Water, One of Man's Greatest Necessities.

TWO-THIRDS OF THE SURFACE OF THE EARTH ARE COVERED WITH WATER.

IT is an interesting fact that the supply of those things which are absolutely essential to life, air, water, and food seems to be regulated by the importance of the demand for each. Without air one could not live an hour, and the supply is absolutely inexhaustible. Water forms a very large portion of the structure of animals, plants, and minerals, and life could be sustained only a short time without it, hence the provision that two-thirds of the earth's surface should be covered by it. Food is a necessity for all forms of life, but one can do without food longer than without water, hence only one-third of the earth's surface is land, much of that is not inhabited, and a large portion of the remainder lacks the proper conditions for the production of food.

WHAT IS WATER MADE OF?

Naturally the first question to be thought of in the consideration of water is—what is it made of? Pure water is a very simple substance, but pure water like pure anything else is very seldom found in nature. As it is very difficult to find air that is free from impurities unless we go to the top of a high mountain or to some other inaccessible place, so is it difficult to find water that is unmixed with anything else. Spring water and artesian-well water are commonly supposed to be pure, but they are often very impure, they often contain poisonous germs, and they usually hold in solution or in suspension more or less of the soil or the rock over which they flow. Water is made by the combination of two gases both of which have been mentioned to you many times. One of them is called oxygen and the other hydrogen. There are twice as many particles of hydrogen as of oxygen in water, but each of the particles of oxygen is twice as large as the hydrogen particle. These gases are very easily obtained from the chemical laboratory, and it is a simple experiment to combine them in the way we have mentioned, water being the invariable result. The only absolutely pure water is that which is distilled, and this may be obtained by boiling water from any source. The steam which is thrown off while boiling is going on is nothing less than pure water, and it can be collected and allowed to cool or condense. If it is desired to keep it pure it must be kept in a sealed bottle away from the air. Pure water which is exposed to air does not long remain pure, for it will quickly absorb impurities from the air, and then it must be re-distilled, or re-boiled if we wish to have it chemically pure.

DIFFERENT KINDS OF WATER.

We have said that pure water in nature was almost an impossibility, and there are therefore as many different kinds of water as there are substances which are dissolved in water. The largest body of water in the world is the ocean, all the so-called oceans being considered as one body. The chief distinction of ocean water is that it is salt, that is, it holds in solution the chloride of sodium, which must therefore be one of the commonest minerals in the world. We have already told you that it is, next to lime, which is the principal element of bone, the commonest of the mineral elements of the body, and that there is not a secretion or juice of the body which does not contain it. About three per cent, by weight, of ocean water is salt. Many other bodies of water, such as springs and lakes, contain a much greater percentage of salt than the ocean and while ocean water is evaporated, in many places, to obtain the salt which it contains, the chief source of supply of this most useful substance is the springs to which we have alluded or the rocks which have been formed by deposits from the ocean, which can be quarried or mined, the same as any other mineral. Salt water is, of course, mineral water, and there are many well-known bodies of water which contain minerals other than salt or chloride of sodium. The carbonate and bi-carbonate of soda are found in many waters and these useful substances are obtained from such waters by suitable chemical processes. Next in frequency to the sodium waters are those which contain lime. Lime water is commonly called hard water, and those whose business it is to wash clothes do not usually like to use it. It is not the most palatable drinking water and its constant use frequently produces unpleasant disturbances of the bowels.

When lime is very abundant in water it frequently settles and takes the form of limestone. The stalactites which hang from the roof of caves and the stalagmites which are built up from their floor are simply deposits of lime which have been formed from slowly-running water. Magnesium rocks are also frequently dissolved by water. The common Epsom salts which are frequently taken as a medicine, and which no boy or girl whom we have ever seen enjoys taking, are nothing but sulphate of magnesium dissolved in water. Carbonic acid is often dissolved in water and some mineral springs are highly charged with it. The Appolinaris water which is so popular as a table water has an abundance of carbonic acid dissolved in it, and it is this which gives it its sparkle and its pungent taste. Most of the mineral waters have medicinal properties and many of the health resorts in different portions of the world are of importance chiefly on account of the healing effect of their waters.

Besides water which contains minerals there are those which contain animal or vegetable matter, this being commonly spoken of as organic matter. If a body of water flows through a bog or swamp it is not only muddy and turbid, but it has an unpleasant taste which is very different from that which flows through sand and rocks. Such water may contain the remains of animals or plants which lived countless ages ago. The numerous oil wells of the world are accumulations of water containing such animal and vegetable remains.

Water frequently contains the germs of serious diseases. Epidemics of typhoid fever are sometimes traceable to the water which has been drunk by those who become sick with that disease. One of the most extensive epidemics of that disease in the history of the United States occurred about twenty-five years ago at Plymouth, Pennsylvania, the residents of which city drank the water of the river which flowed by it. More than twelve hundred of them became sick, and many of them died. The disease was finally traced to a miner's cabin on the mountain side many miles away. In that cabin a man had been sick with the fever and the discharges from his bowels were thrown upon the snow at the cabin door. When the snow melted, the germs in the discharges were washed into the mountain stream nearby. The stream carried them to the river, and the river distributed them, in their deadly mission, among the people of Plymouth.

WATER AS IT OCCURS IN NATURE MAY BE VERY HOT OR VERY COLD.

You have all heard of springs in which water bubbles up almost ice-cold, and perhaps some of you have drank refreshing draughts from them, when you were hot and tired. Such water is protected from the heat of the sun, is constantly in rapid motion and is surrounded by cool rocks. It is far more agreeable and satisfying as a beverage than the stagnant or slowly moving water in ponds and rivers, which is warmed by the sun's rays, and is insipid to the taste with the vegetable matter which it contains. You have also probably heard that in different parts of the world there are streams and springs in which the water is heated to the boiling point. Many springs of this variety are in the Yellowstone National Park, and in some of them the internal pressure is so great that water and steam are forced out of them many feet upward in the air. There are well known hot springs in Arkansas, in Virginia, and in many parts of Europe and elsewhere, and the mineral substances which they contain have a healing effect on disease of various kinds and draw many sick people to them to bathe in them and to drink them. More wonderful still is it that in so cold a country as Iceland there should be boiling springs called *geysers* which for ages have been pouring and spouting great streams and clouds of water and steam and stones. Is it not strange that these fires in the interior of the earth by which the water is heated should burn so long and never go out, or be exhausted?

DIFFERENT FORMS IN WHICH WATER APPEARS.

Did it ever occur to you that water is one of the substances which is constantly appearing in three different forms? The vapor in the air which is constantly arising from the ocean and other bodies of water and which we can not see, the clouds which float along the sky, the mist which hangs over the earth, night and morning, the fog which frequently covers city and village, as with a blanket, and the steam which rises from the spout of the tea kettle are one and all the same form of water—water in its finely-divided state, water in the form of vapor. The ice over which you skate so merrily on a brisk winter day and which is stored up for refreshing draughts during the heat of summer is nothing but water which has been brought to a temperature below 32°F., that is, below the freezing point. The vapor, the ice, and the fluid in the spring, the brook, the lake, the river, and the ocean are all one and the same substance, and this substance is always and only a combination of two parts of hydrogen with one of oxygen. The rain which comes down in gentle showers or mighty torrents is but the moisture which has been evaporated from oceans and rivers and lakes, stored in the clouds and in the atmosphere and when the atmosphere has become filled with it, or is saturated, has fallen to the earth. The snow, and sleet, and hail are only drops of water which have been frozen or chilled and then have dropped to the ground. All these interesting facts teach us the great variety there is in the workings of nature, and the beauty and usefulness which are everywhere present in natural objects if we would only open our eyes and look upon them.

WHAT PART HAS BEEN PLAYED BY WATER IN THE MAKING OF THE WORLD?

The world, as we have told you, is very old. It has taken countless ages for it to reach the condition in which you behold it at the present moment. The great masses of rock which are scattered over it were not laid down in a day nor in a year. Those which are principally due to the action of heat were more quickly formed than those which were built up inch by inch, and layer by layer, through the long centuries. Dana, the great geologist, tells us that water takes the lead among the forces which have been instrumental in making the rocks, in excavating the valleys, in shaping the mountains, and in recording the progress of the earth. As it flows over rocks it gradually wears them away. It holds them in solution for a while and then drops them elsewhere to form a new deposit of rock. The salt in the ocean comes from sodium rocks which have been dissolved, and after a time it has been deposited again in beds of rock salt. The river Nile is a good example of water as a carrier of earth. Each year it overflows the land on its banks, deposits the earth which it bears in its current, and then flows on. Thus the land has gradually been built up out of the water, and the same plan has been constantly carried on by other rivers and streams over the entire earth. Water wears holes in some of the rocks and enters into and forms a part of others. It has excavated great canyons thousands of feet in depth, like that of the Colorado, it wears away great cliffs, like that at Niagara, and it makes great caves like the Mammoth Cave in Kentucky. It may be confined in rocks two or three thousand feet in depth, until the boring of an artesian well lets it out. An artesian well in Paris is two thousand feet deep, another in St. Louis is three thousand feet deep. When water at these great depths within the earth is heated by internal fires it may produce earthquakes, tidal waves, and the outburst of volcanoes.

SOME OF THE USES OF WATER.

One of the most important uses of water is its power of carrying various substances from one point to another. Heavy substances like rocks and stones it simply moves or pushes or rolls along the bottom, depositing them finally where they can no longer be moved. Soil or earth is added, and in due time new land will thus be made and an island will appear. Lighter substances, like wood, float upon its surface, and are thrown by the waves upon the shores, or are detained, like the logs which the lumberman floats down a stream, at some convenient place where they can be used; or they may obstruct the channel of a stream, until moisture and heat causes them to decay and break in pieces. Water also forms a highway or road over which ships and boats can travel bearing the commerce of the world, and carrying passengers from place to place. Water may also carry substances which are suspended in it. Thus the soil is washed away from the ground by the wind and rain and by the currents of streams and is finally deposited upon the surface of the ground. Thus the rocks which are worn away by the waves and tides are carried along in the form of dust or powder and dropped where they will gradually make new layers of rock. Water is also very useful as a mixer or diluent. There are many fluids which are not adapted for use until a sufficient quantity of water has been added to them. Take for example, many of the medicines which the doctor prescribes. If they should be used undiluted they would often be harmful rather than beneficial. The acids or sour medicines, which are frequently prescribed might do injury to the tissues of the body if they were taken without a sufficient quantity of water. The bitter medicines often cause such wry faces and such unpleasant feelings when not suitably diluted that the doctor, nowadays, dislikes to get the ill will of his patients by giving them these medicines in their natural condition, and so he accomplishes his object and, at the same time, pleases his patient, when he adds water and perhaps other things to make them less unpalatable. Many other substances which are used in various arts and trades, may be used more economically and often more efficiently when mixed with a suitable quantity of water. But more remarkable than all these is the dissolving power of water. It will not dissolve everything and we have given you examples of substances which it either carries upon its surface or bears along in suspension. Very many substances, however, are entirely dissolved by it, that is they are changed from a solid to a fluid form. Put a teaspoonful of salt in a glass of water and hold it up to the light, and the salt will gradually disappear while you are looking at it. It is all in the water, and the water is just as clear as it was before. Now add a handful of salt to the water and you will note that some of it settles at the bottom of the glass and remains undissolved. What does this mean? It means that water will dissolve certain substances to a certain limit, and when that limit is reached it will dissolve no more. This is what is called a saturated solution, and no matter how much more you may add to it, it will either settle at the bottom or be held in suspension. Some substances are dissolved much more readily than others, that is, water will hold a greater quantity of them in solution than of others. Another very important use of water is its ability to generate power, and every boy and girl has heard of water power. To develop power the water must be in motion, and it must move against some other object. Long ages ago men began to take advantage of this fact, and made wheels upon which they allowed water to move or fall, then as the wheel rolled around they connected it with machinery of some kind and thus made the water do work for them. So it was made to grind wheat and corn, to run machine shops and factories, and within the past few years it has been harnessed to dynamos and behold, we have the water power changed into electricity. It is water also which is put into a boiler and heated until it is changed into steam. The steam is then collected in pipes and tubes and cylinders and by its pressure power or power of expansion is made to drive locomotives and to cause all other kinds of machinery to do work. Imagine for an instant the effect upon civilization and upon human beings everywhere if there should be no water. So are we not right in saying that water is the greatest of all contributions and helps to human industry?

NECESSITY OF WATER TO LIFE.

We have told you that without air, or at any rate without oxygen which is the essential part of air, there can be no life. Even the minute forms of life called bacteria which are so infinitesimally small that only a microscope of high power will detect them (though they are of the greatest importance in the workings of the world), require water in some form. If we wish to cultivate these bacteria we must place them upon a substance which contains more or less water. From these low forms of life all the way up to man we find water to be a necessity everywhere; without water everything which has life would die. How is it with us in the summer when the rain is withheld for weeks and perhaps for months? The grass dies, the streets are hot and dusty, the crops fail, and the animals suffer. Blessings like water are so common and so abundant that most of us are apt to forget how essential they are, and do not appreciate them until the customary supply is limited or cut short.

Perhaps you do not know how large a part of everything which has life is composed of water. The beef which you eat is three-fourths water, before it is cooked, so is one-half of the egg, three-fourths of the potato, one-tenth of the beans, one-third of the bread, and nearly nine-tenths of the milk. In the human body the blood is eight-tenths water, the bones nearly one-seventh, the muscles three-fourths, the brain eight-tenths, the ligaments three-quarters, even the teeth one-tenth, while the secretions of the body, the gastric and pancreatic juice, the bile, the lymph, the saliva, and the perspiration contain from nearly nine-tenths to ninety-nine one hundredths of this all-important substance water. Taken as a whole, seven-tenths of the entire weight of the body consists of water. You must remember that we are constantly taking in water not only in the liquids which we drink, but in almost every particle of food we eat and if we should attempt to eat food from which all the water had been taken out it would be so dry we would have difficulty in chewing it and we could hardly swallow it unless we were able to mix it with saliva after chewing it a long time. Each day that a healthy adult lives he takes, on an average, more than five pints of water into his body in food and drink, while in the wonderful laboratory within the body where hydrogen and oxygen are separated from the substances which are there broken up, an additional four-fifths of a pint are manufactured. Water being so essential to life it is no wonder that much thought and money and time have been expended in making the supply as abundant as possible wherever men are gathered together in villages, towns, and cities. This is no idea of modern times for in the ancient cities of the world, whose ruins have been studied, one of the noteworthy facts is the care which was taken in giving the people an abundant supply of water. The aqueducts which supplied ancient Rome with water show wonderful engineering skill and also that the Romans did not stop at any expense in bringing water from great distances to their city.

In the chapter which was devoted to the subject of food we spoke of the great value of irrigation, and of the vast tracts of barren and desert land which had become useful and fruitful only after water in proper abundance had been brought to it. The water supply of cities and villages is today one of the most important problems which government has for its consideration. In many places it is still necessary to bring it from great distances. A large portion of the water supply of New York City will in the near future be brought from a source more than a hundred miles away. Water for cities and villages must not only be abundant but it must be potable, that is, pleasant to the taste. It must be as free as possible from animal and vegetable life, it must not have bad tasting minerals in it, and above all things it must be free from the germs of disease. The water of the ocean though it is so abundant is utterly unfit for drinking purposes. It sustains an inexhaustible amount of life within it, but it would destroy human life if we had nothing else to drink. And yet, strange to say, if it is boiled, and the steam collected and condensed, it becomes perfectly suitable for drinking purposes. The health of any community depends as much upon the quality and quantity of its water supply as upon any one thing, and hence every citizen should be interested in seeing that it is as good and as abundant, as can be obtained.

CHAPTER XVIII.

Sleep.

WHAT IS SLEEP, AND WHAT HAPPENS DURING SLEEP?

SLEEP is one of the forms of rest which is required at short intervals, for a longer or briefer period of time, by all living animals. The first thing which we notice in a sleeping animal, no matter what kind of an animal it is, is that he is unconscious; that is he does not know what is going on around him. He does not even know that he is alive, and for that reason sleep is sometimes beautifully spoken of by the poets as "the sister of death." He does not want food or drink, and if you attempt to give them to him you will awaken him and that particular period of sleep will then be at an end. He is not conscious of danger, and the house may take fire, or a burglar may enter and steal the property, or his life may be threatened, but as long as he sleeps he will know nothing about it. The hunter sometimes comes upon wild animals while they are sleeping and may, perhaps, kill them without giving them a chance to awake and defend themselves. Whales are sometimes found sleeping upon the surface of the water and are attacked by sailors while in this helpless condition.

When one is sleeping and in a perfectly healthy condition the muscles are at rest and relaxed. There are sometimes twitchings and contractions of the muscles during sleep, especially in children, and almost everybody turns occasionally from one side of the body to the other. Should this happen very often we say that such a person is restless in his sleep. It is what is called involuntary motion, that is motion which is made without any effort of the will, and does not necessarily mean that it is caused by disease. The majority of individuals as well as the majority of animals lie quietly during the period of sleep—the muscles are in repose. During healthy sleep the breathing is regular and somewhat slower than during the waking hours. When we are awake, we breathe faster than usual if we are working hard or climbing a hill, or if we are excited; and if we are in deep thought we may breathe more slowly than usual, but when we are asleep, unless something is wrong with our internal machinery, we breathe slowly and regularly until we awake. The carbonic acid which we are constantly giving out with the breath is less abundant during sleep than when we are awake, another evidence that our machinery is slowing down. The pulse beat is slower during sleep than when one is awake, which means that the heart, that pump which is always at work, is pumping with less exertion and less force than during the working hours. Most people sleep more comfortably when stretched in the horizontal position than when sitting up. One of the most important things which happens during sleep is the inactivity of the brain. There is not always complete inaction, for some people have the bad habit of carrying their business and their worries to bed with them and even when asleep they do not entirely throw them aside, about which we may have something to say when we consider the subject of dreams. You must not confuse this inactive condition of the brain with the unconsciousness of stupor or disease. Unconsciousness may occur entirely apart from sleep, and so may inactivity of the brain. An idiot, for example, may have a brain which is partly or totally inactive, and many another person with a brain of good working power may have an inactive brain in consequence of fatigue, exposure to cold, or wet, laziness, the influence of various poisons, etc.

That there is less blood in the brain during sleep than when one is awake is simply saying that there is more blood in any organ when it is working than when it is at rest, but this should be considered, in part at any rate, as an effect of sleep rather than its cause. Volumes have been written upon this subject and many different views have been given with which it is not necessary nor desirable to confuse you. In general, it may be said, that the brain during sleep does not think, will, plan, or do any of the thousand things which it does during the hours of waking and working.

WHAT CAUSES SLEEP?

Sleep is not always produced by the same causes. That which produces sleep in one may cause wakefulness in another, as Lady Macbeth said of the drugged and drunken and sleeping servants who were in the bedchamber of the murdered King Duncan:

> "That which hath made them drunk hath made me bold;
> What hath quenched them hath given me fire."

A baby sleeps almost the whole time, not so much because he is tired as because this is the principal way which nature has appointed to enable him to gather strength and to prepare his machinery to do the work of life. He is unconscious, he is quiet, and most of his organs are inactive because that is the way he is to gather and store up strength. An animal goes to sleep in his hole or den in the fall and remains asleep until the warm and sunny days of spring, not because he is tired or hungry, but partly because he is benumbed by the cold and partly because a prolonged sleep is nature's way of preparing him for the work which he has to do the following season. A boy or a man who has played or worked all day long and has become tired out falls asleep as soon as his head touches the pillow because his muscles and his internal organs are worn out for the time, and quiet and rest and sleep will give them a chance to begin over again. The same reasoning applies to one who is exhausted with prolonged brain work, or who is weak and benumbed with cold and wet, or who is worn out with sorrow or fear or passion, or emotion of any kind; sleep comes to all alike with refreshment and renewal of strength. Sleep comes to many at a particular hour of the day or night because the body acquires the custom or habit of taking that kind of rest at that particular time. Darkness encourages sleep in many others. The birds sleep when the darkness comes on because that is for them the natural thing to do at that time. Some years ago when there was an eclipse of the sun and the darkness came on during the daytime the fowls went to roost, and the birds slept as if it were already night. Sleep often overtakes one after eating, digestion calling for an extra supply of blood in the organs which have that duty to perform, and withdrawing it from the brain. This seems the more probable as an explanation because, at such a time, the brain is usually incapable of doing hard mental work. You probably know of many people who are accustomed to take a nap after the midday meal. In tropical countries almost everybody takes the siesta or noonday nap. Prolonged heat makes one sleepy, also impure air in a crowded room, also the action of the poisons which are called narcotics. Chief among the narcotics is alcohol which so many people use in the form of beer, whiskey, brandy, or some other kind of liquor. When the stimulating or exciting part of alcohol has done its work it is followed by the paralyzing effect upon the brain, and sleep follows until that effect has passed off. There are many other poisonous substances which paralyze the brain and produce sleep, and sometimes more of them is taken than the brain and blood can dispose of and the sufferer dies from narcotic poisoning. This should impress you with the great danger of using such substances and with the importance of using them only under the guidance and direction of a wise physician who knows what their action ought to be and who also ought to know what should be done when more has been taken than is necessary and useful. There are many other causes which will produce sleep, but those which we have mentioned are some of the principal and most important ones.

WHAT IS THE RESULT OF SLEEP?

When sleep has been natural and undisturbed and continues until one awakes of his own accord, as we say, there is a feeling of refreshment and invigoration, and a desire to be at work again. No matter how tired the boy or the man was when he lay down, when he awakes his fatigue has departed, his muscles are strong and active again, and his mind is clear and ready to resume its work, whatever it may be. The time of the baby is divided between sleeping and eating, and his first thought on awaking, if we can call it a thought, is the nursing bottle or the mother's breast, and if he does not get it promptly you all know how he expresses his feelings in the matter, "with no language but a cry," as the poet Tennyson says. A horse or a dog after awaking shakes himself, as if to start his blood in motion again, and steady him for whatever activity the day may have in store for him. Many people have a habit of yawning, not only when they are drowsy and desire to sleep, but when they awaken and are not quite sure whether they have had sleep enough. It usually means that more oxygen is wanted by the blood, and this is supplied with the deep inspiration and expiration of that act. You have probably heard of the ground hog or woodchuck which sleeps all winter until the second of February, and then crawls out of his hole and looks around. If he sees his shadow he concludes that spring will be here in six weeks, but if he does not see it there is no telling when it will come, so he goes back into his hole, curls himself up, and takes another long sleep.

The aged are especially competent to tell us of the blessing and comfort of sleep. Perhaps you have noticed that your grandparents do not work as hard as they did a few years ago. They get tired more easily than you do, and they do not attempt to do the tasks which your father and mother find easy and pleasant and interesting. They are a living lesson to you of the wearing out which sooner or later must come to all of us, just as happens to your house and your clothes, your books and your shoes. But notice your grandparents after they have had seven or eight hours of refreshing sleep. They are bright and cheerful, the weary look which you saw on their faces last night has passed away, and they seem like different persons. Why? Because they have felt the restoring and renewing and invigorating effect of sleep. The same is true of the sick. Many a time after the doctor has performed a severe surgical operation does he wait with the greatest anxiety to see if his patient will sleep, and when the nurse tells him that the patient has slept six, eight, or ten hours out of the twenty-four he feels that the battle has been won, that nature is restoring the strength which was wasted by the disease and by the operation, and he knows that if no unforeseen accidents occur the patient will get well again. So is it also in the case of those who are sick with fever or other exhausting illness. When the patient is wild with delirium and weakened with the poison of disease, hour after hour passing while he is restless and sleepless, then the doctor knows that life is trembling in the balance. But if a change comes, it matters not how or from what source, and the patient becomes quiet and sinks into peaceful and restful slumber, the doctor draws a sigh of relief and tells the anxious friends that if the sick one can only get a few more hours of sleep the enemy will be overcome and the beloved one will be brought back to health again.

WHAT DO THE POETS SAY ABOUT SLEEP?

More than one poet has written songs in praise of sleep, perhaps because he has felt in his own body and life the great relief and comfort which it brings. Young addresses it in his *Night Thoughts* as

> "Sleep, balmy sleep, tired nature's sweet restorer."

Shakespeare in that matchless tragedy Macbeth, which you must all read, makes the guilty murderer say

> "Methought I heard a voice cry—Sleep no more,
> Macbeth doth murder sleep, the innocent sleep;
> Sleep that knits up the ravell'd sleave of care,
> The death of each day's life, sore labor's bath,
> Balm of hurt minds, great nature's second course,
> Chief nourisher in life's feast."

Again and again in this same marvelous drama, as well as in others, the poet refers to the wondrous, the soothing power of sleep, and the loss, even the agony of the one who is deprived of it. Wordsworth, Tennyson, and many other poets have also sung of the comfort and blessing of sleep.

EVERYTHING WHICH HAS LIFE REQUIRES SLEEP OR SOMETHING WHICH CORRESPONDS TO IT.

We have seen that nothing which has life can maintain it longer than a few minutes without air or oxygen. We have also seen that nothing can live more than a few days without water. We have seen furthermore that without food life must cease. To these three necessities of life we must also add sleep, or something which corresponds to it. You have read of engineers on railroad trains who were obliged to work constantly night and day in charge of their trains until they became utterly exhausted and fell asleep with their hand on the lever of the engine. You have probably read of soldiers who have slept at their post while doing picket duty, and have been shot as a penalty. Doctors who have worked night and day, trying to relieve the sick and injured, sometimes fall asleep while at the bedside, or when going from house to house. Do you suppose such people willfully neglect their duty and responsibility and thus expose to destruction the lives and property which are entrusted to their care? By no means. Some who are in such positions of trust are doubtless careless and indifferent as to the results, but in the majority of cases the reason for the fault, when fault there is, is the utter inability to resist the drowsy charm of sleep. Exhausted nature demanded rest, and they were unable to resist the demand. We have occasionally read of individuals who said that they never slept. That seems impossible, and while some things happen which can not be explained by any known law of nature, it would seem more reasonable that such people must be mistaken in their statements or their belief, and that sleep sometimes overcame them when they were unaware of it. The average person, man, woman, or child who goes without sleep two or three nights becomes exhausted, his face declares his suffering, and if that condition of sleeplessness should continue he would die as surely as he would die without air, water, and food. The animals are as dependent upon sleep as human beings. You could not keep a horse at hard labor more than a few hours at a time. After he has become exhausted no amount of coaxing or beating will make him work, he is simply unable to work until he has had food, and rest, and sleep. The birds, the insects, and every kind of animal must have a recurring period for rest and sleep. For the very simple forms of animal life which have no brain and no lungs there is a form of rest which corresponds to sleep, and this refreshes them and restores their vitality as sleep does for the higher animals. The plants also show the operation of the same law; the flowers close their petals as the sun goes down, and the active growth of the day ceases or is diminished at night. The trees lose their foliage in the fall, the sap flows to the roots, and they remain inactive until the spring comes again. This is for them both rest and sleep. The plants which we take into our houses in the autumn, after they have blossomed all summer, must have a period of rest, even though we give them an abundance of sunshine and moisture.

RESTFUL AND DISTURBED SLEEP AND THEIR CAUSES.

Sleep is restful when there is simply unconsciousness with regular breathing and heart action, from which one awakes refreshed and prepared anew for the work of life. It is typified by the sleep of the healthy infant or young child or the healthy animal. Health, therefore, is the first condition of restful sleep. Moderate fatigue or weariness not only encourages sleep but produces such muscular relaxation that the sleep is usually sound and refreshing. The Bible says "the sleep of the laboring man is sweet," and there is no difficulty in understanding what is meant by that statement. Boys and girls know how enjoyable sweet things are, and sleep, like the other necessities of life, is intended not only to satisfy a requirement, but to give pleasure and enjoyment also. But sleep is not always restful and enjoyable; one who is frequently awakened during the night, or who is aroused by danger or sickness does not enjoy his sleep. If the night is cold and there are not enough bedclothes, how uncomfortable you are, and how far from pleasant and restful will be your sleep. The sleep which is produced by medicines often finds one unrefreshed when the morning comes. The man who has been drinking and carousing may pass hours in the heavy sleep of the drunkard, but in very many cases he awakens with a headache and confesses that he has been a fool and is paying a heavy penalty for his folly.

Those who sleep immediately after eating a heavy meal often find little rest and refreshment from it. Digestion takes several hours, and if you put extra work on the digestive machinery at a time when it should be resting you should not be surprised that your sleep is not restful. All parts of the body should be at rest during sleep, and hence hearty meals at bedtime should be avoided. Mothers realize this when they give the children only a light supper and then put them to bed. Perhaps you will ask, why is it, then, that babies almost always sleep immediately after eating, perhaps even while they are at the mother's breast? The reason is that a baby's stomach holds but little, it takes but three or four tablespoonfuls at a meal and its food is of a kind that is quickly digested. If it takes too much or if the food is not of the right kind, there will be no sleeping until the offending food is disposed of, just as happens with older people who do not get the right kind and quality of food.

Sickness is often a cause of disturbed sleep, especially in children. Those who are subject to worms or convulsions, or various forms of nervous disease are frequently restless and uneasy during the sleeping hours. Many who have acute illnesses, fevers, inflammations, and various surgical diseases are also poor sleepers, and as such sufferers are especially in need of the healing action which comes from sleep, its disturbance or its absence becomes a more serious matter than it is to those who are in ordinary health. Even animals may have disturbed sleep either from disease, or indigestion, or some other cause. Cats and dogs will twitch and whine and show in other ways that their sleep is not restful.

DREAMS.

You all know what is meant by dreams. Some are pleasant and refreshing, and some are horrible and exhausting. There is no period of life that is free from them; the baby who can scarcely talk has them and so has the old man who has nearly reached his journey's end. Dreams signify that the brain, which in ordinary sleep is resting like the other parts of the body, is still working. That is why one who dreams most of the night is not refreshed by his sleep. Brain action means that the blood is coursing through it more or less abundantly. We have told you that in ordinary sleep the blood supply of the brain is greatly diminished, but when there are dreams it probably means that there is more blood in the brain than is required for restful, dreamless sleep. There may be a law by which dreams are regulated, but if there is nobody has yet discovered and clearly stated it. Dreams are sometimes influenced by events which have made a deep impression upon one's life. For instance, one has a great sorrow and dreams about that which has caused it, or one has been deeply engaged in business plans which have signally failed or signally succeeded, and the events are all reviewed during the hours of sleep. Sometimes one dreams of the events of childhood or of other things which happened long ago. A curious thing about dreams is that they so often refer to the past and so seldom to the future. This would indicate that memory has more or less to do with them. Sometimes they are influenced by guilt and remorse, sometimes by the baser passions and appetites, sometimes also by the very highest and purest motives and feelings. Not infrequently they come when one is struggling to digest a heavy meal. Animals, especially dogs, dream as well as human beings, and if we are to judge by their behavior when they are apparently dreaming the experience is very real to them and sometimes very unpleasant. The fantastic dreams of those who smoke opium, pipe dreams, or use other narcotics, show the powerful effect which drugs may have upon the imagination. Whether the dreams are good or bad, pleasant or otherwise, they are outside of normal healthy experience, and sometimes are worthy of the investigation of the skillful physician who can "minister to the mind diseased."

TOO MUCH SLEEP AND TOO LITTLE SLEEP.

Although sleep is a necessity it may be excessive just as one may take too much food. Lazy and stupid, and very fat people are apt to waste time by sleeping too much. You remember the fat boy in *Pickwick Papers* who was always asleep when he was not eating. Prolonged hot weather not only takes away one's energy, but causes constant drowsiness. Disease may also cause constant weariness and desire for sleep. The sleeping sickness among the Africans which, as we have told you, is due to the development of poisonous germs within the blood, after one has been bitten by the tsetse fly, is of this kind and invariably ends fatally. If there are some people who sleep too much there are many more, especially in these hustling modern times, who sleep too little.

Want of sleep or insufficient sleep often becomes a disease which is called *insomnia.* Those who are habitually in a hurry, those who are worried and nervous, those who suffer much from pain or sorrow or remorse are often the victims of insomnia.

HOW MUCH SLEEP IS REQUIRED?

An infant sleeps the greater portion of the time. As life progresses the hours of sleep are lessened. When youth is reached, ten or twelve hours out of the twenty-four are sufficient, and when mature life comes a regular allowance of eight hours will, usually, satisfy anybody who has good health. In old age there are many who are satisfied with five or six hours of sleep, while others go back to the condition of childhood and have a desire to sleep most of the time. There is, however, no rule in such matters which will apply to everybody.

COMPARISON BETWEEN SLEEP AND FOOD.

It is often interesting to note the respective influence of sleep and food. There are many instances, especially in times of severe illness, when sleep is far more important than food. The body will at such times reject food and it demands sleep. A person can sometimes go for many days without food if only he gets plenty of sleep. But when one is convalescing from a severe illness the demand and craving for food in great abundance are often very urgent. Each of these essentials, sleep and food, has its important business to perform and if we are watchful we will so regulate our experience that the body will get enough of each, and as seldom as possible, too much or too little.

CHAPTER XIX.

Work, Play, and Rest.

EVERY LIVING THING IN THIS WORLD, THAT IS GOOD FOR ANYTHING WORKS.

WHEN we look out upon the world of nature around us we see what a busy place it is: the plants are doing the best they can to grow, fighting against the attacks of insects, against the various diseases to which they are subject; busy in taking from the soil and the air and the sunlight those things which will make them grow and prepare flowers and seeds for the plants which are to follow them and take their places. This is their form of work. The animals are busy in getting food for themselves and their young, some of them like the bees, the ants, and the squirrels not only working for that which they require from day to day, but laying up something for the future. You would scarcely think that a baby works, and yet if you watch him when he is not eating or sleeping, you will see that, if he is a healthy baby, he is almost constantly in motion, kicking with his little feet and legs, throwing out his hands and arms, and moving his head in all directions. He is following nature's law that work is an essential part of life. How is it with the organs in the interior of the body? The heart is always at work; so are the lungs; the brain works and rests; the digestive organs work when there is food to be digested and assimilated, and the other parts of the body have their work to perform each at the proper time and in its own way. Here again we have work as one of the essentials of life. If any organ or tissue stops working it becomes dry, withered, and useless. Perhaps you have seen the limbs of a person who is paralyzed. How different they look from those which are healthy. They are shrivelled and small, and show that there is something about them which is entirely wrong. It does not matter that they are unable to work, nature makes no exceptions for any cause, but says imperatively—if you do not work neither shall you thrive. She does not say this to stones and rocks. Why? Because they have no life to sustain. They remain stones and rocks until they crumble into dust or are otherwise broken up. Plants and animals work, minerals do not.

The heir to the throne of Great Britain is called the Prince of Wales. The words which he has for his motto are the two German words *Ich diene,* which mean *I serve,* implying that he wishes the people to know that notwithstanding his exalted place he serves or works, and we do not know of any better motto that a man in high position could have. The President of the United States is a most industrious and busy worker. From morning until night, every minute is occupied with some duty, and if anybody thinks the President has an easy time he ought to go to Washington and see how hard it is to get a chance to speak to him, he is so continually occupied. The men who control the great industries of the world, the presidents of banks and insurance companies and railroads, the managers of mines and great department stores, the men who keep the world moving in every form of useful activity, work very hard, and most of them work many hours every day. But not alone in these positions of great responsibility do we find men and women obeying this important law of nature. It was written in the Bible many years ago, "In the sweat of thy face shalt thou eat bread till thou return into the ground," and this decree which has seemed to many to be intended for a very harsh punishment was really one of the kindest arrangements that could have been made, for the people who work hard are usually not only the most useful, but the most happy and contented also. Does a real true mother begrudge the long hours of work for her children, "from early morn till dewy eve"? Does the father object to his toil on the farm, in the shop, in the factory, in the office? No, if he is the right kind of a man he rejoices in the opportunity to work and be useful, no matter how tired he may get, or how hard the work may be. How is it with the man who is out of work, who has lost his job, who walks the streets hour after hour, and finds no opportunity to use his hands in his trade or occupation, who goes home to his wife and children and tells them he can't get work, and that therefore they must go hungry? Is it any wonder that such men get discouraged, and break down and go to pieces? Work, therefore, is not only useful and necessary, but it is honorable, for it enables us to help others. The best feeling any man, woman, or child can have is that he is not living day after day merely for his own welfare or amusement, but that he is doing something all the time to make somebody else comfortable and happy. It is hardly necessary to ask if children and young people can and ought to work. If what we have stated is true, everybody ought to work, young as well as old, and any boy or girl who grows up with the idea that he doesn't wish to work, does not need to work, and that he hates work, has a very unpromising future before him, because it is from the ranks of the lazy and the idle that most of the "good for nothings" are recruited.

VARIOUS WAYS IN WHICH CHILDREN MAY WORK.

There is scarcely any household, perhaps it is more correct to say there is no household, in which any member of it should be idle and lazy; this includes the children as well as the grown people. Perhaps you know that in a hive of bees there are three kinds or classes, one large queen bee, who is the mother of the little bees which are coming, a great number of small female bees who do all the work and gather all the honey, and a small number of males, called drones, who do no work at all, who are lazy and idle, and live upon the industry of the workers. We are sorry to say that there are not a few homes of human beings where there are idlers and drones who live upon the work of the industrious members of the family, and the boy or girl who intentionally and persistently shirks work is not likely to make a successful man or woman.

It is always pitiful to see school work neglected or shirked, because it is just as certain that those who do so will be sorry for it when they grow up as it is that they will be glad if they stick to it and work hard at their studies. Many boys and girls who must work and earn their living feel the need of schooling and education so much that they are glad to go to night schools after the day's work is over. Depend upon it those who are thus anxious and thirsty for knowledge will get it and will get the benefit from it too. There are many households in which the struggle for food and shelter and clothing is so keen that everybody in it, even the children, must work whenever work can be obtained. This is unfortunate, for childhood being a period of preparation for the hard work of mature life ought not to be devoted to the task of getting a living. But we must take conditions as we find them, and if children must work let us help those who say they must not work at tasks which belong to grown people, they must not work at night when they ought to be sleeping and gathering strength, they must not work at trades and occupations which destroy their health, and either kill them in early life or make them sick and dependent upon others. It is a thousand times better that men should make less money, than to make it as many do at the expense of the health and vitality of children. And as the children will be the grown-up citizens in a few years, how foolish and unwise it is for any State to permit its children to do those things which will certainly result in producing citizens weak in body and in mind.

OVERWORK.

Just as we should insist that everybody ought to work, so should we warn everybody against overwork. It is perfectly true that some occupations cause more fatigue than others. A few hours of hard work of some kinds will make one so tired that he will be unfit to do anything more until he has rested. Those who work in tunnels and similar places, in compressed air, can work only about three hours at a time. Farmers often work twelve or fourteen hours or even more every day. Doctors often work twelve or fourteen hours a day, and may be called up once or twice during the night. These are some of the exhausting occupations, while there are others in which there are only six or eight working hours, and in which the work is not hard. Much of the overwork which is required comes in the form of emergency or unexpected tasks. Engineers, mechanics, tradesmen, and others are subject to such calls, and sometimes they can not be helped, but they often exact severe penalties in the form of sickness and weakness.

OVERWORK IN DANGEROUS OCCUPATIONS.

Workers on railroad and telegraph lines, workers in poisonous chemicals, workers in complicated machinery and in the construction of lofty buildings, and in many other occupations connected with our modern life, are always in peril, and the longer their hours of work the less strength and self-control do they have to resist these dangers. Hence the necessity that they should be protected by law from overwork, and that their lives and limbs should be insured against accident. The government of every state and nation has as one of its most serious duties the protection of the lives and health of the citizens, and great as are the failings in this respect in many cases, the conditions are growing better each year. They are far better now than they were in ancient civilizations when a large portion of the people were slaves, for whose comfort and welfare the rulers gave little thought or care.

PLAY IS AS NECESSARY TO HEALTH AND COMFORT AS WORK.

The old saying that ''all work and no play makes Jack a dull boy'' is full of truth and meaning. We can learn a very useful lesson from the animals upon this subject. Who has not noticed the playfulness of young animals, puppies and kittens, lambs, calves, and colts? How frisky they are, and how much they seem to enjoy life! ''Playful as a kitten'' is a saying with which you are all familiar. Not only the domestic animals, but the wild animals also show this beautiful instinct of playfulness. It is not limited to the young of these animals for we often observe the same tendency in those which are mature. Play is therefore a natural inclination and to seek to repress it is to bring about an unnatural and therefore a very undesirable state of affairs. Especially should the spirit of playfulness and the love of play be encouraged in children. Childhood is, as we have already said, the period of preparation, the period of development, when all the organs and tissues are growing. They grow best when they have plenty of exercise and use, and such exercise comes with vigorous active play, such as walking, running, swimming, rowing, games of ball, tennis, and all other games which bring the muscles into active use, and make the blood flow freely through every part of the body. Show me a boy who does not love games and out-of-door sports, and the chances are that he is sick, or not properly made, or is forming bad habits which take away the natural desire to play. We are fortunate in living in a time when people are recognizing the right of children to play, and to have suitable playgrounds, and to enjoy themselves. Country boys and girls have no trouble in finding plenty of room to play. They have the fields and the woods, the lakes and ponds for their playground, and the country therefore is the most desirable place to bring up boys and girls. But alas! thousands of them have only the streets of the city, with an occasional visit to a city park. Even so, many children make the most of their opportunities and get all the fun they can on the city streets. The plan of using empty lots, and school buildings out of school hours and even the flat roofs of houses for playgrounds which is now so popular in many cities, is a splendid one for the health and enjoyment and future well-being of thousands of children. So, too, is the plan of encouraging children to cultivate flowers and vegetables in the small gardens which are being established in many places. It is to be hoped that school boards and city governments everywhere will encourage all such movements for the welfare and happiness of children.

CAN PLAY HAVE AN INFLUENCE ON THE MIND?

Most decidedly it can. A game of ball not only gives pleasure and exhilaration, and makes the heart beat quicker and the blood flow faster, and all the internal machinery of the body work better than before, but it cultivates some very important mental qualities for boys. Running for bases makes them quicker in action. When a ball is pitched, the catcher must calculate quickly; the striker must act with precision in trying to strike it. Ball playing also brings in the spirit of competition and stimulates the will and is very useful in many other ways. It brings boys together and keeps them very busy out-of-doors, and when they are playing ball with all their might there

A HEAVY LOAD.—The play of country children.

isn't any chance for them to get into mischief of any kind. Boys who are idle are very much inclined to get into mischief, proving the truth of another old saying that "Satan findeth mischief still, for idle hands to do."

CAN PLAY BE OVERDONE?

Yes indeed, and it often is overdone, especially by boys, for the spirit of play is often much stronger than the spirit of work. Many a boy decides to take the risks and play truant when the first spring days make the open fields or even the city streets far more delightful and attractive than the crowded school room with its hard and disagreeable lessons. Then it is that the music of the brook is alluring and woos a boy to go fishing. Then it is that the birds returning from their winter vacation call him to the woods and fields. Or if a circus is coming to town, many a boy will struggle with his conscience for a while to decide whether he ought to omit the school or the circus parade, and finally determine in favor of the parade. Of course decisions of this kind are unfavorable to the growth of the character for which the boy is laying a foundation. However attractive and even useful play may be, it should never be allowed to take the place of duty, and this is true for every age and condition of life. There are some communities in which the energies of the entire population are occupied with play, either providing it for others, in which case, of course, it becomes a form of work, or receiving such enjoyment and pleasure as it may bring. From such communities you seldom hear of anything that is of more than momentary happiness and benefit, of anything that really strengthens either the individual or the community life. Either an individual or a community which is wholly devoted to pleasure and play is following an unnatural course, for in nature, while play has its place, it is subordinate to work.

PLAY OUT-OF-DOORS COMPARED WITH INDOORS.

For most people, old and young, out-of-doors play is much more beneficial than indoors. The reason of this is largely, perhaps principally, because it implies that one gets, out-of-doors, the largest possible amount of the life-giving oxygen. A man or a woman, a boy or a girl, never looks better and never feels better than after he has spent a month or two on the ocean, in the mountains, in the forest, or amid the rustic joys of life upon a farm. This is the natural way of living, and we should all live out-of-doors as much as we can. But in most climates during a large portion of the year the conditions of the weather are such that it is not pleasant to be out-of-doors, either for play or work, hence we must have play indoors.

Remembering the benefit of out-of-door life, we must make the first requisite for our indoor play that it be accompanied with plenty of air; that our houses, churches, theaters, and halls should be well ventilated. Unfortunately, at least in public places, this is very often neglected.

AMUSEMENTS IN GREAT VARIETY FURNISH PLAY INDOORS.

The object of all the forms of amusement or indoor play is not merely to assist in giving and keeping health, though this is an important part of it. It is for the purpose of giving pleasure and happiness, which are proper ends for every human being to strive for. We do not hesitate to say that, first of all, our amusements should not be immoral, whatever else they may be. Amusement which costs the lowering of the moral sense or the moral tone is a very poor investment, and the thousands of young people who are unwilling to think so often pay a very high price for their pleasures. Remember it is not the joy of the moment which is the true measure of the value or the cost of a pleasure, but the result which comes afterward as it affects health, character, reputation, etc.

BATTLEDORE AND SHUTTLECOCK.—A splendid indoor game.

Just as we would encourage healthful out-of-door games, so would we recommend all the innocent indoor amusements,—parties, friendly calls, dancing under suitable restrictions, private theatricals, and many other forms of entertainment which will encourage neighborliness and friendly feeling. Music is by all means to be cultivated, both in the home and in the places of public meeting. There is no form of amusement combined with work which has a finer effect than this upon the mind and the disposition, and nothing that is more refining and enjoyable, provided the music is of good quality. Public lectures, if properly selected, are not only important means of education, but the source of keen enjoyment, as well. The great city of New York and many others are doing noble work in this direction, and are giving the people the finest kind of amusement, combined with instruction in the courses of free public lectures upon all subjects of human interest.

The theater is a most useful means of amusement and should be a most healthy one, but beware of the bad, vicious, and immoral plays which are everywhere forced upon the public attention. Valuable as the theater is in many ways, its influence, especially upon the young, is unfortunately too often demoralizing, because of the worthless character of the plays presented. Do not forget the inestimable value of good reading as a means of recreation and profit. The great number of fine public libraries in all parts of the country leaves no excuse for anybody for not cultivating in early life the habit of reading. If Andrew Carnegie, as a great philanthropist, had done nothing more than to establish the libraries which are to be found in so many cities and villages, he would deserve to be remembered with everlasting gratitude. There are many opportunities, too, for young people to interest themselves in hospitals, churches, and other benevolent institutions and so obtain the keen pleasure which comes from the sense of doing something which will be of help and service to others. The great thing to be remembered always is that enjoyment, pleasure, play should not be selfish; should not be a means of squandering precious time, but a means of self help and education, and of service for others.

REST IS THE OPPOSITE OF WORK.

Just as necessary as work is rest; nobody can work all the time. There is nothing made which does not require rest, that is, cessation from work to prolong its period of usefulness. Even the heart, which, as we have told you, never stops beating until it stops altogether, has a long beat, a short one, and then a short period of rest, otherwise it would wear out long before it does under the existing arrangement. Clocks and watches must be stopped and cleaned and rested occasionally, and so must boilers and furnaces and all kinds of machinery. Especially does everything that has life require a period of rest. The plants, having grown and borne flowers and seeds and fruits, must have rest before going over the same course again. The leaves fall from the trees and during the months of winter the trees rest, preparatory to renewed work in the spring.

DIFFERENT FORMS OF REST, OR WAYS IN WHICH REST MAY BE TAKEN.

We have just told you of some of them and wish to emphasize the fact that *rest is as important and essential for everything that has life as are air, and food, and water, and work.* The principal form of rest for human beings is sleep, and it will be unnecessary to add to what has been said about that. Another form of rest is in cessation from work, laying down the tools, giving up the play and exercise, and simply sitting, or lying down quietly and allowing the tired body to gather and regain strength for renewed activity and work. Another form of rest consists in change of occupation. The celebrated scientist, Professor Virchow, said that after working hard all day in his laboratory he rested himself by attending the sessions of the German parliament in the evening and taking part in the debates. Reading brings rest to many, and the perusal of an interesting book upon some engaging subject leads them to forget all about their fatigue, their worries, and their tasks. The same is true of music, the theater, or some other form of diversion and amusement. Rest, therefore, may consist in inactivity or it may consist in diverting the mind and the body by calling upon another set of faculties which have not been in use and so are prepared to do their appropriate task. Some people require much more rest than others, because they are sick or have not the capacity for work which some others have. Others rest too little, they work too hard and too continuously or they allow themselves too little sleep, and we say of such people that they "burn the candle at both ends," and are soon worn out. A reasonable amount of rest, in whatever form it is taken, enables one to do his work much more efficiently than if he cheats himself by doing or trying to do more than his physical organization was intended to do. We must not lose sight of the fact that we are made on different plans and have different scales of endurance, and that a task which is easy for one may be very difficult or impossible for another. We can learn useful lessons from the arrangement of the days and the seasons: the night follows the day, when nature is quiet and inactive, and the period of growth and fruitage is followed by the winter when growth stops and everything takes and enjoys its rest.

CHAPTER XX.

School Life and its Relation to Physical Health.

THE CHANGES WHICH HAVE TAKEN PLACE.

IF THERE ever were stories more interesting than Grandfather's war stories, they were those which Grandmother told of her happy school days. Can you not hear her now as she pictured the queer little old school house, with the backless benches, rude desks, old box stove, the ''square'' of blackboard, small windows which were not made to open, and the rough board floor which frequently served the purpose of blackboard as well, especially when coveted pieces of crayon escaped from the guarded box on teacher's high desk?

How vividly she pictured the school books which, Grandmother always explained, were made to study, not to look at, and which were passed on from one generation to the other. How they were covered, and guarded, and prized. Each child in the family used the book in turn and memorized its pages.

Then the children used slates with home-made frames which banged noisily when they were moved. Grandmother always felt that even with all the noise, slates and pencils were far cheaper and better than tablets and pens.

Do you remember how it sharpened your appetite to hear her tell of the shiny tin dinner pail in which each morning was packed her lunch of hard-boiled eggs, bread and jam and other delicacies? And can't you see the old water pail standing on the bench in the corner of the room, and the rusty dipper hanging from the pail?

You shuddered and ached a little when Grandmother told you of their few recesses and long school hours. But the school term was short and time was precious.

Even as you recall your interest in these experiences, you are grateful that you live in the time of modern school buildings with all their comforts and advantages. Great changes have taken place not alone in the provision of school buildings and grounds, but in the way in which the schools are conducted and in the subjects taught. Today, school children have many interesting books, they are not held to the study of two or three subjects which all must study regardless of likes and interests, but are given the opportunity to study those subjects which they like best and which are connected with the things they think and do. These changes have not come by chance. Persons interested in schools and in school children have studied and worked and planned to bring these things about. This is why great colleges have been founded for the purpose of training teachers so that they may learn the best ways of teaching different subjects; that they may better understand what children need, and want and should have; and that they may be able to give them the best and most helpful things, in the best and most helpful way. This explains why teachers today study the health interests of their pupils, why they encourage play and games, why they study the best ways of teaching manual training, domestic science, agriculture, music, millinery, dressmaking, home-nursing, art, nature study, and many other things which grow out of the interests of school and daily life.

We must not think that teachers are the only persons interested in schools. There are many men and women who are devoting their lives to the study of their needs and possibilities, to the preparation of courses of study, to the selection of the best text books, and to the training of persons who shall be fitted to plan helpful things for the school children. These people are bringing happy surprises to us each year. A few years ago who even dreamed that we should today have playgrounds, gymnasiums, and swimming pools? We do not know all of the good things yet in store for us.

Our schools have grown into small worlds. Each pupil belongs to this happy school world to which he comes, to live and act in relation to others. He serves, he is helped by those whom he serves. This is the reason pupils are allowed to study those things which belong to their daily life interests. They are really and truly living—not merely getting ready to live in the future.

For really there is no future entirely separated from the present—today simply meets and loses itself in tomorrow. You remember Grandmother used to say, "Tomorrow never comes." How hard it was to understand and how you would wait for the "tomorrows," only to have them turn into "todays." So when you plan the things you are to do when you are a grown-up, it means you must take care of the todays; for yesterday, your tomorrow, was today.

What excitement there was at the dinner table the night your brother announced that he was going to leave school and go to work. He did not want to go on with high school work any way. It was much more interesting to watch the great engines come puffing into the car shops, or to gaze with shivering admiration upon the workmen who balanced themselves fearlessly on the swinging beams in the great steel-framed buildings.

From the time Big Brother had built such marvelous things out of old spools and tin cans to the time he made a flying machine which almost flew, every one in the family said he would be a great man sometime. Now a place in the shops was offered him and he was eager to leave school and begin real shop work.

Father understood the situation and tried to explain the necessity for an education and soon made Big Brother see that without special training and study he could not advance in his work. Today there are so many specialists, it is necessary to know as much as possible about one's work if one is to succeed. So it was decided that Big Brother should work in the shops during the day and attend Trade School at night. And how he enjoyed it! The night you were allowed to go with him you remember what queer feelings you had as you sat near and watched him study and draw and experiment. You wondered what the queer lines meant, why there were so many wheels and bands and why all those people were there working away as hard as they could. Then you were told that many young people are not able to attend high school and then go on to college. Many have to go to work even while they are in the lower grades. Then there are others like Big Brother, who wish to begin at once to learn some special trade. For these and others, our special Trade Schools have been formed.

The public schools are broadening and increasing their courses now to meet the new demands. It is possible to continue your high school course and at the same time give your attention to the special thing in which you are interested and which you expect to do when you are grown.

If you decide to devote your time to some special trade or industry, you receive special training in those lines, or if you wish to prepare for one of the professions, such as teaching, or law, you are able to enter courses which will prepare you to continue those lines of study. This tells us again that the schools are looking out for the needs of the boys and girls and that they are trying to meet these needs in the best way possible.

At present it is necessary to have these Trade and Night Schools where pupils who are forced to go to work can spend their leisure hours preparing themselves to do well some particular kind of work. These young working men and women are someday going to be leaders. Can you tell why? Today we are proud to be called "working people." You know it makes little difference the kind of work one does. Much more depends upon how one does it. Perhaps you can get Father to tell you what "dignity of labor" means, or have you taken the hint from what we have said?

So we were all happy over Brother's work and successes, but Mother especially was concerned about his health. He had fewer hours for rest and play. You noticed that at night schools the pupils were not given recesses and play periods as you are given in school.

Too often young people get so interested in their work that they forget they have delicately-made bodies which require great care if they are to be kept in order. Father knew all this when he so often said, "Son, if you would care for your body as well as you do for the engines in the shop, you, too, would run more smoothly, and make better time."

Brother would soon lose interest in the engines if they were simply machines, unable to do things. His greatest joy comes when he feels a great shiny engine begin to throb with life. It puffs, and snorts and lunges, and then moves strongly, confidently, powerfully out of the shops and glides smoothly over the glistening rails, drawing after it tons and tons of weight. How easily it does the work, too! Could anything be more wonderful? One thing, perhaps, and that is this beautiful, wonderful human engine—the body. What can it not do when it, too, is in perfect order? And what a weak, miserable thing it is when it is not able to do the things it wants to do. Just like a broken engine.

Have you ever seen the great engines which pull the trains over the steep mountain roads? Great, powerful machines they are. Everything must give way to them. They go steaming along like mad, throwing their fiery breath and puffing out great clouds of smoke. Kings of the road are they. Yet what more helpless thing than one of these iron monsters when it is broken down? There it stands "dead" upon the track. The wheels still, the fire gone out, the great throbbing sides, cold. It can not even move itself out of the way of those trains. It must be pushed aside by those who a short time ago feared it. It is powerless until it is repaired. We wonder if it can ever again be as strong as it was before?

So the human engine which runs along so smoothly when all is well with it, sometimes gets out of repair if it is not well cared for, and then you know what happens. All of our work and study will mean little to us if we are unable to do the things we plan to do.

But our parents are not the only persons who have thought of this. The question of guarding the health of boys and girls has spread not only through our homes and public schools, but into the industrial world, and has resulted in great movements for the protection of children in factories, workshops, stores, and on the streets; in fact, in every line of work where children are employed.

There are laws which compel children to attend school for a certain length of time; there are also laws which provide for the proper care of children during these years. This is why studies are so planned that pupils may have just the right kind of work at the right time; why school buildings are made beautiful and healthful and attractive; why children are given time to romp and play and rest; why teachers are interested in their scholars' health as well as in their education.

THE REAL MEANING OF EDUCATION.

Does it seem strange to you that the nation should take such good care of its children? Can you see why this is when you remember what we said about our todays and tomorrows? Boys and girls are the country's young citizens. The nation has need of them—they are her pride and protection. We need strong, happy, independent citizens not alone for protection, but that they may be able to live their lives happily; to plan and do great and helpful things; to be of real service to the people about them, and that they may represent today the strong, vigorous, useful citizens which we shall have tomorrow.

But aside from this training for citizenship, what may we expect our school training to give to our boys and girls? Knowledge? Yes, but not for the sake of learning facts. History is a dry subject indeed when it means nothing but the memorizing of dates. But when it becomes to us the story of human life, what could be more fascinating? It then helps us to enter into that life with a broader understanding and more tender sympathy than we have known before.

Botany is a most lifeless study when it means nothing but long lists of meaningless terms. But it is changed into the most interesting study when it leads us to the fields and woods and brings us into close, human touch with plant and flower life.

So the schools wish to give not knowledge alone, but experience and inspiration which will help boys and girls to live, and grow, and do. We want pupils to have high ideals, steady minds, strong physiques, and moral courage to make those ideals come true.

Pupils sometime desire what they may consider a stronger argument in favor of the long period during which they are obliged to attend school. From the kindergarten through the high school is a long time for one to go to school—five days each week, four weeks each month, and nine months each year—and for years and years! Is it worth while? What does the school give in return for this that will help one make a living?

This money side of life the school does not over-look. The interest taken in industrial education is proof of this. Business men are asking for young people who are especially trained. The best positions are open to such, and a high school diploma is always a recommendation.

But the school must offer more than knowledge and an education which fits young people to make money. It must give with these, the power for their realization and enjoyment. This explains in still another way the strong emphasis which the school places upon health. Think of the vast sums of money our schools are spending just to guard the health interests of children. Why is this done?

If we could separate health from everything else in life, and think of it as something entirely by itself, it would be of very little value. It is not worth very much striving for, just to be able to lead a painless life, unless that life is going to enable one to be of more worth in the world.

The person who faces the day with a realization of strength and power, who feels like doing things and knows he can do his work well, is the ideally strong person. But he takes satisfaction not merely in being well, but rather in being able to do well the things he wishes to do.

So the school is working with the home in the attempt to care for the health of the children, not simply that they may be well, but because they can not be happy and useful and good unless they are well.

School life is so pleasant and becomes so naturally a part of life that pupils can not appreciate the planning and thought and study back of it all. School days are the most important ones in life. They are the todays which decide so largely what the tomorrows are to be. Realizing this, great care is taken that our schools may meet the demands of the pupils for whom they are maintained.

Since children spend so many hours of each day at school, and since they are forced to attend a certain length of time during school age, it becomes a duty to make the schools as attractive and healthful as possible.

In Grandmother's time, this was a less serious problem. Then, people were thankful enough for a school house of the crudest sort where children might meet for a short term each year to study reading and arithmetic. The pupils walked miles to school, ate plain, wholesome food, had acres of fields and woods for playgrounds, they climbed hills and trees, skated and swam, rode horseback and worked in the home and fields. No wonder that Grandmother looked questioningly at you when you told her of your supervised walks in the parks, of your fenced playgrounds, sand piles, merry-go-rounds and pieces of apparatus; of your gymnasium, swimming pool, skating rink, and bowling alley; of your school physician, school nurse, and physical examinations. Not strange that she sighed and said, ''Poor child.''

But one must remember that life is different today, especially in the great cities, where people are crowded together away from the sunshine and blue sky and green fields. These artificial things have been provided in place of the out-of-door work and play which most people do not have today. Yet when we think of the many advantages and comforts and opportunities which present life gives us, we are glad to live today since we know that with proper care we can live and work and play now safely, healthfully, happily.

SCHOOL BUILDINGS.

Educators believe this, too, and they have taken a large part of the responsibility of providing such conditions that the pupils may attend school and yet be safe, and well, and happy. This does not mean that this great responsibility rests upon any one person. There are many factors involved. Among these, the most important perhaps are the school buildings, teachers, and pupils. We are going to talk about each of these separately for a moment. Do not get the idea that one exists apart from the others. This is not true. They are all bound together. The most beautiful school buildings in the world would be useless if there were not inside of it wise, earnest teachers, and happy, eager children.

The many school buildings all over this country stand as proof of the deep interest and trust which people hold in our schools. Do you remember when the new school house was built in your home city? Every one was interested from the wee kindergartners to the old janitor in the city hall. Father discussed the part of the taxpayer. Mother knew the plans from the basement to the top floor. You knew the men who had planned the building. They had become familiar friends. Why?—had you not on your way to school seen them day after day bending earnestly over the great sheets of blue paper? The straight white lines and tiny figures meant nothing to you until Brother explained that to the builders those white lines pictured the new building, and that they served as patterns which they were to use in somewhat the way Mother uses a pattern in cutting a dress. Then how wonderful it all seemed, and you walked even more slowly than usual when you passed the men with the great blue prints.

The building was discussed in your home, at school, on the street, at church—everywhere by everybody. You heard people talk of the Board of Education, the Board of Health, and other Boards about which you knew nothing; yet you knew that each had a part, and that all those people were using their knowledge and experience to give you the best building possible.

At last it was finished. On that September morning, when you entered the broad, bright hall for the first time, you turned and looked back at the lovely grounds, and for the first time realized that the location selected for the building was one of the most desirable in the city. Do you suppose this came by chance?

Long before a plan was drawn, there were persons who spent much time and thought on the selection of a location or site for the school building. You would be surprised to know how many things there were to consider.

Of course, the cost of the land was a problem to be solved. Today, especially in our great cities, even when great sums of money are spent, it is impossible to buy enough land to provide broad walks and roomy playgrounds. This is why some of our city school buildings are as high as business blocks. There is a growing demand for accommodation for pupils. There is no space to build ''out''—we are forced to build ''up.'' We are glad that the roofs and courts of such buildings can be turned into playgrounds and roof gardens.

But not alone is the cost of land to be considered—the building must be centrally located, and at the same time it must be in as quiet and clean a place as possible, away from the noise of trains and street cars and the dust and confusion of markets and factories.

Yet, this is not all. The kind of soil upon which the building is placed is of importance. Clay holds moisture. Sand and gravel are more easily drained. Which would be the more desirable? The matter of water supply is a great consideration, as is also the level of the land upon which the building is placed.

So you see it was no little matter to decide simply upon the location of the new building. Now, are you beginning to feel what a great undertaking it is to provide a schoolhouse? It is not strange that so many people are concerned in it.

When it comes to the building of the house there are even more things to be considered than in the selection of the site. The building must be so placed that it will receive the rays of the sun in the best way. It must be sanitary, convenient, beautiful. Can one building be all of these? This question may be answered by looking at new school buildings in the cities in which they are located. Do you notice how fine and substantial they are?

A building is truly beautiful and artistic when it is built to best serve the purpose for which it was intended. When doors and windows are made and placed to admit the greatest possible amount of air and sunshine, little thought need be given to the placing of ornamental gables and cornices.

You see, then, that builders of schoolhouses have much to consider aside from the mechanical and architectural features. They must look away back of these things into the real needs and purposes of school life. When they have erected a beautiful building, their work is not done. They owe more than this to the people who have confidently paid for it. The building must be so built that it will provide every possible comfort and protection to the children who spend so many hours of their time within its walls.

This is a heavy responsibility, for it involves among many other things the general location and planning of the building; the foundation, and building materials; arrangement, equipment, and decoration of rooms, halls, laboratories; the provision of cloak rooms, toilets, washrooms; the proper supply of water for drinking and flushing purposes; modern and reliable sewerage, plumbing, heating, and ventilating systems; correct lighting; provision of proper protection against fire; arrangement for playgrounds, and all the rest.

All of this is easily said, but each part involves much thought, time, and expert work. Perhaps as you go through your building you will take new interest in the things which have been placed there for your comfort.

You sit in your comfortable school-room and watch the snow as it is drifted by the cold north wind, yet you are warm and happy. You do not have to crowd about a stove trying to protect your face from the heat while your toes freeze. Grandmother has told you of such experiences. You do not see how your room is heated. If you think about it at all, you simply know you are warm.

Perhaps your teacher will take you down into the basement some day and have the engineer show you the great furnace and pipes and wonderful machinery which so silently and mysteriously work away all day without your thought and knowledge just to keep you warm and well.

While the engineer is explaining the way your building is heated, he will also show you how you are provided with fresh air.

How surprised you are to find that all this time and thought and wonderful machinery have been used simply to give you pure air to breathe.

The heating of a building seems a somewhat simpler matter than the ventilating of it. If the heating apparatus is working properly, we need have little concern about the temperature of the room, but with the ventilating system it is different. We can not safely trust to it to do all the work without our help. We are thus given a chance to help in this regard. So, after each recitation we open the windows and let the pure, fresh, out-of-door air flood our room. Then we close the windows and our ventilating system takes care of the air supply until the next airing period.

To be sure, in town and country schools there are not so many modern improvements possible, but even in these schools, with thought and effort, pupils may be made comfortable. If there be no modern ventilating system, windows may be lowered and raised from top and bottom, and pupils may have their play periods during these ‘‘airing seasons.’’

Another simple way to ventilate a room is to fit a board four or six inches wide under the lower window sash. This prevents a draft by directing the current of air upward between the two sashes. There are always simple devices which may be used, by means of which, with few modern conveniences, school children may be protected and made comfortable.

But with all modern equipment the entire problem of providing a healthful school home for children, is not solved. Under the best conditions school children are brought into very close contact with each other. Realizing this, laws have been made requiring certain floor space and air supply for each child. You see, the schools are trying to prevent sickness and suffering by giving to school children healthful surroundings.

Proper desks and seats, working material and well lighted rooms are provided that eyesight may be guarded. Fresh air, pure water, long play hours, and protection against disease and accident are provided, that school children may be safe and well.

You enjoy fire drills. You are taught how to use fire escapes, ropes, and other emergency apparatus, that you may be able to protect yourself in case of danger. You are examined by your school physician, cared for by the school nurse, and watched and protected by your teacher. All this comes to you so naturally and pleasantly that you do not stop to think what it means. The fact that all of these provisions are made, shows what our government thinks of the value of health to the citizen and to the State.

So the ideal school building is not simply a creation of brick and mortar. It represents a growth—a consideration of vital needs and conditions of school life whose demands the schoolhouse is built to meet. Let us now put inside of such a building teachers and pupils of the right sort, and we shall have a power which shall be the pride and hope of the nation.

THE TEACHER!

Your teacher's name soon becomes a family name. Next to mother I wonder if any one seems more a part of your life? What confidence your parents have in her, too. They confidently sent you to her before they even knew her name. As you grow older you will be able to look back over your school years and realize how your life has been influenced by certain teachers. It is not strange that they feel the necessity of making that influence strong and wholesome.

Teachers are feeling more and more an interest in the physical life of their pupils. They are being trained to guard the health of the children. One result of the physical examinations which are given in our schools, has been the drawing together of parents and teachers. Parents are frequently ignorant of conditions until teachers are trained to discover such and bring them to their notice. A knowledge of such conditions often prevents serious illness and much suffering. The sympathetic teacher who knows her pupils, both mentally and physically, can do many things to make their school life happy and worth while.

Have you ever boasted that you had the best teacher in school? You always appreciated her successes and envied her mental ability. But is there a child or grown-up person who does not especially remember the teacher who used to go out on the playground and play? Do you remember the time it dawned upon you that there were real, live teachers who could run, climb, catch a ball, jump and "shout for sides?"

You will remember the teacher who was always in her place; who stood up straight and looked at you with clear, bright eyes; who did everything in a calm, controlled way; who entered into your life not in a make-believe way, but honestly and happily; because she was alive, and glad to be; who spoke clearly, laughed gaily, played enthusiastically, and sympathized sincerely. Her influence will remain with you. What more convincing argument could she have given in favor of physical strength and health? What could make you desire such more than the influence of her wholesome, helpful personality?

Perhaps you are thinking that with the ideal buildings and teachers we have described, there is little left for the pupils to be and do. Have you stopped to think that all this is planned for you? Without you, it would mean nothing. It would be like a wonderful birthday party, all planned and prepared, but with no children to enjoy it.

THE RESULTS SOUGHT FOR THE YOUNG.

We have seen that many provisions have been made for the protection and education of the young. They are surrounded by conditions which make study easy and pleasant; the physical side of life is cared for; work is adjusted to physical strength; school hours are shortened; play hours lengthened, and every possible care taken to keep school children well and strong. Our people are trying to surround pupils with wise, helpful teachers and a wholesome school environment.

What may we expect of a pupil who is receiving all of these influences and advantages?

Study—not that he may learn many facts because it is convenient and perhaps pleasant to do so, *but because the experiences and opportunities of his daily life are such that the meeting of these demands earnest, sincere duty.*

Service—helping those about him—not because he feels under obligation to do so, *but because his life can express itself in no other way.*

The efforts and influence of a strong, vigorous body,—not that he may be able to escape pain and suffering, *but that he may be able to live his life joyously and well, that he may be able to do the things he wishes to do, and that he may wish to do things helpful and worth while.*

Citizenship—not alone that his school, city, State, and nation have need for citizens of the highest type, and have spent freely to educate such, *but because the ideals which have become his, as he has lived and learned and served, can be realized in no way save through the devotion of a life with all its possibilities for service—for citizenship.*

CHAPTER XXI.

The Home and Home Influences.

WHAT a variety of thoughts come rushing before us with the word home! If you are in a foreign country, with what eagerness you read the papers for the news of home, how anxiously you await for the postman for a letter from home, and when the time comes to take the cars or the steamer you can scarcely wait until you are brought back again to your country and to your home. How the heart of the traveler longs for the sight of those who are in the home—father, mother, wife, husband, children, brothers, sisters, and how sad the heart, when the home is made desolate by death. Or if you have been away at school, how you long for the vacation to come so that you may go home, and what joy and happiness there is when you get home. A little child often strays away from its home. Perhaps a policeman finds him in the street crying and sobbing, and when asked what he is crying about, he seldom says he is hungry or has a stomach-ache, but almost always whimpers through his tears, "I want to go home." And so the true home is the place where the affections dwell.

HOMELESS.

If there are sweet thoughts and pictures which come floating before us with the word home, how different is the case with the word *homeless.* How the sympathy of the whole community is aroused when a family is turned out of its home, into the street, especially if it is winter. Think of it! no roof to cover you, no cheerful fire to warm you, nothing but the open street or the field. No comfortable bed at night which you can call *your bed.* How unhappy the lot of the homeless, and yet there are thousands of them especially in the great cities, old and young, male and female, who sleep where they can, often glad to get the shelter of the police station, picking up food wherever they can find it, and as for clothes, getting them—who knows how or where, unless they beg or steal them. Tramps and hobos are homeless, many newsboys and street urchins are homeless, vice and poverty break up many homes and scatter their members—who knows where! You remember the great earthquake in San Francisco a few years ago, and how thousands of people were made homeless for weeks and weeks! How often fire destroys homes and places their members at the mercy of charity or compels them to take such help as the Red Cross society or the government can give them. Riots and massacres make people homeless, sometimes by the thousand, as the Jews have been in Russia, in recent years, and the Armenians in the Turkish Empire. War always brings destruction, and desolation and homelessness.

Did you ever think that, as a rule, the animals are homeless? A bird is pushed out of the nest as soon as it is able to fly and does not return. The nest is its home for only a very short time. Seldom does a bird use an old nest for its home, it is too much interested in its own ideas of nest architecture. Some of the animals, to be sure, have holes and nests and burrows, but with the most of them the home is where they happen to be for the moment, and especially where the food supply is. Do you suppose a fish has any idea of home? Most of the domestic animals change from one place to another as they may be compelled to do so, and so far as we can judge there is nothing to show regret or sorrow in making the change. If they have enough to eat and are comfortably sheltered, that seems to be all they require or desire. Perhaps the dog is an exception, he often seems to be attached to his home, but probably his attachment is rather for his master and the other human beings of the home than for the home itself. How different all this is from that which occurs in human beings. There are, indeed, some people of a roving disposition who are dissatisfied with any kind of a home except for short periods, and some tramps are reported to have said that they enjoy their careless, homeless life, but to most people the word *homeless* is full of dread. Going to the poorhouse has few attractions, and especially is this a bugbear as old age comes on. Very many people find the incentive to thrift and saving in the hope that they may thus provide the means for obtaining a home when they no longer have the strength to work, and that they will not become stranded and homeless.

THE VALUE OF HOME DEPENDS UPON ITS SURROUNDINGS AND ASSOCIATIONS.

An easy distinction to make is a bad home compared with a good home. The home is bad or good chiefly by reason of those who are in it. Home is not dependent upon having a fine house or the possession of a great number of beautiful things. It is no secret that some of the most uncomfortable and unhappy homes on the face of the earth are those in which there is no lack of anything that can be bought with money, the best of everything to eat and drink, pictures and books, fine furniture, everything that ministers to physical comfort, but no happiness,—nothing but discontent, hatred, and suspicion. On the other hand, how many thousands of homes there are throughout the country where there is no luxury, perhaps not even the comforts of life, and yet those who are in them are perfectly happy and contented and would not exchange places with anybody. The poet Burns has drawn a beautiful picture of such a home in *The Cotter's Saturday Night,* and I would advise all my readers who are not familiar with it to read it at once, for an illustration of the joy and happiness which the humblest home can give.

THOSE WHO ARE IN THE HOME GIVE IT ITS IMPORTANCE.

If there were no living person in a home what would it amount to, however beautiful or grand it might be. Certainly there are many who enjoy camp life in the wilderness, or a visit to the house of a friend, or a few days' stay in a fine hotel, but none of these places is home, and who does not get tired of them in a little while and become homesick? Home is where the heart is.

"His home the spot of earth supremely blest,
A dearer, sweeter spot than all the rest."

A boy or girl loves and longs for the home because mother and father are there, and perhaps brothers and sisters. A man longs for his home because wife and children are there, dearer to him than anything else on earth. There is no greater misfortune in life than for a person, young or old, to allow the love of home to die, for he is taking from his own life the choicest comfort and blessing of human life.

HOME SHOULD BE A PLACE OF HEALTH.

What would you think of a farmer who crowded his sheep, or his cows, or his pigs into places in which there was not room enough to walk around or lie down, who never cleaned out his barns, and who didn't give his animals enough to eat? Surely you would say he ought not to expect to have strong, healthy animals, and he would not have them, and one reason at least why there is so much disease on certain farms is because the animals are not properly treated. And yet we could take you to many a home, both in the city and in the country, where the people, the human beings, old and young, are treated with just as little care as the animals of the shiftless, ignorant farmer. In thousands of tenement houses, and in many houses which are not tenements, there are too many people for the air space, there is no attempt at cleanliness, and there is either not enough food or it is not of the right kind. You will remember that you have been told what proper food was and how much of it was required for a day's ration. Now under these conditions just mentioned would you expect healthy men, women, and children? No, and you would not get them. Remember the things which we have told you human beings must have in abundance if they would enjoy good health—air, water, food, and sleep, and how can they have them, under such bad conditions? Is it any wonder that such people die young and that they have all sorts of diseases, and that they do all sorts of things that are bad? No, a home, in order to be the abode of health must have free access to the air, plenty of windows and ventilators; it must be clean, free from dirt and filth, free from disease germs, and free from bad habits. We have said something to you about the disease which is called tuberculosis, which is a very common disease, and attacks old and young, male and female. Its commonest form is that in which the lungs are the victims, and people frequently give it the name of consumption. This is a disease which is particularly common in the homes of the poor. One of the family gets the disease, perhaps the father or the mother. They may be too poor or too ignorant, or too careless to have a doctor or to remove the sick one where proper care would be given. As the disease progresses the patient is compelled to spit out quantities of decomposed material from the throat and lungs, and this material contains the germs which produce the disease. The floor sometimes becomes soiled with it, it dries and the germs are set free in the air of the room. The other members of the family inhale them and it often happens that one after another is attacked with the disease, and the entire family may be wiped out in a few years. Worse than that, the germs of the disease may settle on the walls or ceiling of the rooms and when the next family comes in the germs may be set free in the air and more human beings destroyed. And yet all of this might have been prevented and the homes made free from this disease, at least, with proper care and intelligence. Happily the people are learning about these matters, and when they get into the habit of taking proper precautions the disease will no longer be so frequent, and the homes, especially the homes of the poor, will be delivered from this terrible affliction. A home can not be healthy, for body or mind, where vice and drunkenness abound. Think of bringing up little children where they must frequently see father or mother drunk, hear vile and blasphemous language, and be in an atmosphere of quarreling and fighting. This is the bringing up which thousands of children are subjected to. Is it any wonder that they become bad themselves, or that they leave the home as soon as they can get away from it, or that they think of it in later years without any feeling of love or desire to go back to it.

THE HEALTH OF CHILDREN DEPENDS GREATLY UPON THE CHARACTER OF THE HOME.

It is true that children who are brought up in bad and unattractive homes are not in them much of the time after they are big enough to go into the street, or to work, or to school. If they were obliged to stay all the time in rooms where there are those who are sick with tuberculosis or other serious diseases, or where there is constant drunkenness, and fighting, and filth, there would be fewer who would live to be men and women. In one sense it may be fortunate that they are driven to the street, and perhaps come home only to eat and sleep. It allows them at least to inhale the better air of the street and sometimes, but alas, not always, to get into healthier surroundings than they find in their homes. Boards of health and city governments are doing much to make the homes of the poor more healthful and decent. They take the sick away to hospitals and sanitariums, they frequently provide nurses for those who are in the home, they quarantine the house when it is visited by infectious disease, and compel those who do not live there to stay away from it, and they are gradually educating many of the people to do those things which will prevent disease. This is all very well and hopeful, but it will only lessen the trouble until the blessed time comes when people will no longer be ignorant and careless and vicious, but will be taught and helped to live like civilized beings.

COUNTRY HOMES AND CITY HOMES.

The picture which comes to the mind of a boy or girl with these words is somewhat different from that which comes to a grown person. A grown person, if he works in the city, thinks of a country home as a place apart from the noise and confusion and busy occupation of his daily toil, where it is quiet, and there are trees along the streets, and there are houses with land around them, and perhaps gardens for vegetables and flowers. Here he can spend the evening pleasantly with his family or his friends, and then have a quiet sleep before going to the city again.

> "Peace and rest at length have come,
> All the day's long toil is past,
> And each heart is whispering,
> Home, home at last."

He thinks of a city home as an apartment or flat, or tenement, more or less convenient, or of a house in a solid block of buildings, quite comfortable usually, and very expensive to keep up and so far from his work that he must take a crowded car in order to get to it. This, of course, is only one view of the country and the city homes, and they necessarily mean a great deal more than this, in either case. A city boy usually thinks of his home, if it is a good home, as the place where his parents and the rest of the family live, where he eats and sleeps, from which he goes to school, and where he sometimes sees his friends. Perhaps he pitches ball in the street, but unless he is a tenement house boy, and some of the finest boys in the world are of that variety, he doesn't make the street his playgrounds. He may go to a gymnasium, or take exercise in his home, or occasionally go to the park to play, but his opportunities for play are very limited, and play ought to form a very large part of the life of a boy or girl, as I have remarked before. A country boy thinks of his home in the same way as the city boy in many respects, but he has many more attractions out-of-doors, he has more opportunity for sports and games, and he has the fields and the woods. In many cases he raises flowers and vegetables, and if he lives on a farm he may have to do certain chores which he doesn't always enjoy, but which are usually good for him. Now if you, boys and girls, could choose your home in city or country, which would you prefer? I would be willing to bet that the majority would choose the country, every time. That is surely the place to bring up children, and I hope the time is coming when it will be more generally felt than it is now that while the city may be well enough as a place of business, or as a home for a few weeks in the year, it is not so desirable for a residence, all the year around, as the country, and this is especially the case in so far as young people are concerned.

EARLY HOME INFLUENCES AND ASSOCIATIONS.

The first few years of life are usually the ones in which the lasting impressions are made; how very important, therefore, that they should be of the right kind. Do you suppose a boy or girl will ever forget the early home life? Suppose he was unfortunate enough to be brought up in a public institution, is he likely to forget it? Or suppose he was in a home where there was no love, and perhaps where he didn't have enough to eat, and where in the winter it was so cold that he sometimes thought he should freeze to death, will he ever forget it? How important it is, therefore, for parents to make home the brightest place on earth for themselves and their children. Why is it that in the New England States there is such a gathering of people on Thanksgiving day? Not because there is going to be a big dinner with turkey and mince pie and other good things to eat. No, it is chiefly because it is the day when the children come home again. They have been away from the nest, making homes for themselves elsewhere, but they have come back to the old home, because it was the home of their childhood, and because their parents were there, and there they will meet their brothers and sisters. It may have been a place where they had to work hard, but they love it, and they no longer think of the hard work, but of the parents who took care of them, and of all the pleasant and beautiful memories of childhood and home. In many of the other States there is a home-coming day which is in many respects similar to the New England Thanksgiving day. Such days emphasize the importance of early associations and the way in which these things cling to us, that if we would have the children come home often, when they are grown up, and long to come, we must give them the happiest kind of a childhood. And it is so easy to make a child happy, and to do something for him which he will remember with gratitude and thankfulness all his life. We can not all belong to clubs and societies and public institutions, but we can all do our very best to make the home with which we are connected the best and the most beloved home possible, for there never has been and never will be a place of such blessed associations or such enduring influences.

CHAPTER XXII.

Light, Heat, Moisture.

THE CONDITION OF THE ATMOSPHERE WHEN THE RAYS OF THE SUN SHINE THROUGH IT.

LIGHT is best appreciated, like so many other things by considering its opposite, darkness or absence of light. It is dependent upon the sun; if there were no sun there would be no light, and only that portion of this globe on which we live is light which is opposite to or facing the sun. Of course each portion of our globe gets its share of light each twenty-four hours as it rolls around the sun. The sun, as you know, is an enormous globe or ball, fixed at a vast distance from the earth, is constantly burning, and like the fire in your stove, the bonfire which you kindle, and every other kind of fire, produces light and heat. As you look at the sun you say its light is yellow, other kinds of light are red and others are white, etc. But you may not know that this yellow light of the sun is not one color, but a combination of seven. When it shines through the water in the air, after a shower and forms a rainbow, you see a mixture of colors. And if you should hold a triangular prism of suitable glass where the sun's light would shine through it upon a dark screen you would see it broken up into a band of seven colors, red, orange, yellow, green, blue, indigo, and violet, and in that order. These are therefore called the primary colors and they are the colors which you saw in the rainbow. The rays of the sun produce not only light but heat, and the heat can be separated from the light, as you would separate water from the things which are dissolved in it. Some of the primary colors contain more heat than others, those which are near the red being warmer than those which are near the violet. We have been talking about the various things which were necessary or useful to life, about air, food, water, sleep, and work, and to this list let us now add light.

WHAT IS THE EFFECT OF LIGHT UPON LIFE?

Let us first consider its effect upon the growing things in nature. Sunlight is necessary, in combination with the green coloring matter in plants, to make the plants grow, and when the sunlight is withdrawn the plants remain inactive until it comes again. If, therefore, there were no sunlight the beautiful green color with which all nature is clothed would disappear and the different forms of life which have the green color would disappear also. It is also necessary to animal life; without it many of the animals would be unable to find their food, for their eyes are not intended for use in darkness, and just as the light is necessary for growth in the vegetable world, so also is it in many of the forms of animal life. How different is the behavior of young animals when they are shut up in the darkness from that which they show in the light; they are quiet, timid, and sleepy, but throw open the doors and let them out into the sunshine, and they will at once run and jump and manifest their pleasure and show the beneficent influence which has been produced by the change from darkness to light. It is precisely the same with human beings; how much more cheerful we feel in a bright, sunny day, than in a dark and cloudy one, and if we were compelled to live in the darkness most of us would desire to die, and very many of us would soon die for there are few people who can keep up their courage and hope and vitality when the light is taken from them.

EFFECT OF LIGHT UPON DISEASE.

There are some forms of disease which are directly benefited by the influence of light. When a person is getting well from a severe sickness there is nothing which is more helpful and cheering to him than to sit or lie in the sunshine. So true is this that many institutions have been established for the treatment of disease by light. The so-called cold rays, that is the blue and the violet, which contain much less heat than the red and the yellow, are especially useful in the treatment of certain forms of disease. Perhaps you may have heard of the Finsen rays and of their use in treating disease. These are violet rays and others beyond them in the band of solar light, when the solar ray is broken up by passing through a prism. These rays beyond the violet, or ultra-violet as they are called, are colorless and invisible to the eye. A few years ago it was quite the fashion to put panes of blue glass in some of the windows in houses, as it was thought that the sunlight shining through them was very soothing and would cure disease, especially disease of a rheumatic nature, and now since Finsen has studied and elaborated the subject with great care, we can understand why the blue glass should be placed in the windows and why it should have such a beneficial effect. Light is beneficial to those who are sick in another way, it kills many of the germs which are known to cause disease. This is especially true of the germs of tuberculosis. If these germs are collected from the material which is expectorated by those who have this disease, and are placed in strong sunlight they will quickly die. Hence you will be able to understand why a visit to the clear air and sunlight of the Adirondacks and other mountainous regions, or an ocean voyage, is often so helpful to those who are suffering with this dreaded disease. There are also other varieties of disease germs which are killed by sunlight and this may remind us of what the Bible says about a great many people who can not stand the light "because their deeds are evil." Light stands, therefore, for that which is good and healthful and wholesome, just as darkness does for disease and for that which is bad.

CAN THERE BE TOO MUCH LIGHT?

Yes, this is possible. If your skin is exposed too long to a very strong light it will blister it or even destroy it. This sometimes happens in the early days of spring when the air is clear, especially if the strong light is reflected from the water. Those who go fishing at such times and whose skin is tender often suffer in this way. Strong light also has a powerful bleaching effect, your mothers and sisters will tell you, and will take the color out of carpets, and furniture coverings and wall paper. Strong light, with heat, may also be used in forcing plants, causing them to grow and mature very rapidly, and perhaps weakening them by such unnatural growth.

ARTIFICIAL LIGHT.

One of the most valuable of modern conveniences consists in the various forms of artificial light. Think of the time when the only light in the house at night came from the fire on the hearth or from torches, when children, and grown people, too, went to bed in the darkness. What an improvement it was when candles and oil lamps began to be used, but even then reading by such a light was neither pleasant nor easy. Now the night is as bright as the day. One of the most beautiful sights in these days is a great city, like Paris or New York, brilliantly lighted with thousands and tens of thousands of electric and other powerful lights. How this artificial light increases human productiveness and the power to work! Many industries are carried on at night with exactly the same activity as by day, the amount of work which can thus be done being nearly doubled. Plants can be forced to grow under the electric light, though not so well as under sunlight.

THE EFFECT OF SUNLIGHT UPON THE DISPOSITION.

We have told you of the healing effect of sunlight upon disease, but even when there is no disease its effect upon human beings is very beneficial. Who does not feel cheerful upon a clear spring morning when the sun is shining and the birds are singing? All the day long if the sun continues to shine it acts like a tonic to the disposition, and makes one much more ready and willing to do the tasks of life than if the day is dark and gloomy. Cloudy, dark days are often useful, no doubt, but they seldom encourage cheerfulness, or gladness, or happiness. They are certainly useful after a long series of bright days in which there has been no rain, when the earth is dry and the crops are dying for want of moisture. Then when the clouds gather we rejoice because they tell us the longed-for rain is coming. But after the rain we are always very glad to have the clouds flee away, and for the bright sunshine to visit us again. An occasional cloudy day is also very useful for boys, because, if they like to go fishing, and I think all healthy boys ought to enjoy that delightful sport, they are usually told that fish bite better on such days. But my experience has been that more important than a cloudy day is to go where there are fish, and to know how to catch them. Unless there are fish to be caught, it matters little whether the day be bright or dark.

DARKNESS.

Darkness is the opposite of light. Not only when the sun is not shining, that is, when our earth is not looking toward the sun, but when there is no light from candle or lamp or electric current. What a calamity to be in darkness all the time, as is the case with those who are blind. For those who have been blind from infancy it is not half so hard as for those to whom blindness comes late in life. The blind do many wonderful things, and some of them seem very happy, but after all it is a great misfortune. So you ought to be thankful, every day, for your eyesight, and do nothing to injure it. Imperfect vision comes quickly enough even with the best of care. You have heard of animals which live in caves and which have no sight or very imperfect vision. Have seen fish with such imperfect vision; living in the dark they not only had imperfect eyes, but their whole nature had been changed, for sunlight brings out that which is best even in animals. You have also heard of those who were prisoners in dungeons and dark cells. Sometimes, but only in rare instances, men can bear such experience for many years. The poet Byron sings of such a man, Bonivar by name, who was confined for years in the castle of Chillon in Switzerland, the poem beginning

> ''My hair is grey, but not with years.
> Nor grew it white in a single night,
> As men's have grown from sudden fears.''

For most of us the darkness would be so depressing that death would come as a welcome relief. With imprisonment in a dark and damp dungeon hope usually vanishes, and when hope disappears either the mind gives way, or life itself goes out. In State prisons there are dark cells where men are placed only when they will not obey the prison rules and from which they are allowed to come out as soon as they will promise to behave themselves. They are cold, damp, and gloomy with no light of any kind in them, and it is a very severe kind of punishment to be shut up in one of them. Darkness has its uses, however, and it would be more agreeable to live in a place where it comes every twelve or fifteen hours than where the daylight is continuous for weeks or months.

Some plants will grow in the darkness, though they lose their green color. Many plants will grow in our cellars and in caves where the daylight seldom comes. Potatoes which have been kept all the winter in cellars can be planted in dry earth in the same cellars in the spring and in a few weeks a new crop will have grown from them. But if the light reaches them they will decay, so that this is a case in which light is actually bad for a plant. You probably know that in the Arctic regions there is darkness for six months at a time, and the people who live there have the intense cold to bear in addition. There is little that they can do during this long night and when the daylight comes again they are much like the animals which sleep in their holes all winter, weak and with little animation. But one can get accustomed even to this, as the Esquimaux and others who live in the far north are obliged to do, and it is said they can be cheerful and happy, though I should think that would be very difficult. With the means which we have of bringing light into the darkness the night is often a time of great enjoyment. Then it is that after the work of the day is over we enjoy the family gathering, or the visit with friends, or the entertainments and amusements, public and private, which are seldom given during the day, that being the time which we devote to work. But the night and the darkness are also the time which is usually chosen for the works of evil doers; "works of darkness" they are properly called. Then it is that vice and crime are busy, the burglar and the murderer and the drunkard choose the night more often than the day for their work. The beasts of prey roam about in the night and seek their food; owls and bats, and certain kinds of hawks, and whippoorwills fly about and are busy during the hours of darkness, while all the birds which have bright plumage and most of those which have sweet songs are sleeping. The greater number of human beings also choose the night for their time of rest and sleep, and preparations for the hard work of life. So that darkness and night have their uses and we could not well get along without them, but in general we can say with safety that prolonged darkness is harmful both to animal and vegetable life, and in order that they may produce the best results they must have light in abundance, not artificial light, but that which comes from the great source of light and heat, without which the world would soon go back again to the condition of barrenness and desert which everywhere existed before the light came.

HEAT SIGNIFIES THE DEGREE OF TEMPERATURE.

When the word *heat* is used you are accustomed to think of that which is hot, a hot stove, a hot day in summer, a hot temper, but that is not exactly what the word signifies in physics, the science which treats of the forces in nature. From that point of view heat means the degree of temperature, and therefore every object in nature has its particular heat, the degree being high in one and low in another. The heat of the minerals varies greatly; it takes less heat to carry mercury through one degree of temperature than it does lead, and far less than it does water. Each plant has its temperature or specific heat, and it takes much more heat for one to do its work, which is growth, than it does another. When we come to animals we find the same differences of heat belonging to the different varieties or species. The cold-blooded animals have a lower body-temperature than the warm-blooded, the former including fish, snakes, lizards, frogs, etc. In the warm-blooded animals there are also differences in the body temperature. Whales, seals, walruses, and many other sea animals live in the water a portion of the time, but their body temperature is much higher than that of the fish which live constantly in the water. Human beings and many of the domestic and wild animals have a temperature or body heat which is normally between 98 and 99 degrees Fahrenheit. Birds, on the other hand, have a temperature which is several degrees higher than that of human beings. But the term heat may also be applied to the atmosphere, and it is very often compared with the heat of something else. If, for example, you say the atmosphere has a temperature of 90 degrees, you mean that the day is a hot one, and that the heat is sufficient to carry a little column of mercury through a certain distance in the tube of a Fahrenheit thermometer, away from the zero point. For convenience water is taken as the standard for the action of heat, and the difference between the freezing point and the boiling point of water is represented on the Fahrenheit thermometer by one hundred and eighty equal parts or degrees, beginning at thirty-two and ending at two hundred and twelve. When therefore you say the thermometer registers 90 degrees F., you mean that there is heat enough in the air to carry water through fifty-eight of those degrees in the thermometer tube.

The term cold is still more indefinite and relative than heat; it simply means a low degree of heat. It might not mean the same to you as to me, for what you consider cold I might think quite comfortable or even warm.

HOW IS HEAT CAUSED?

Heat may be caused or produced in a great variety of ways. A swarm of bees buzzing in the hive will produce heat and raise the temperature of the hive several degrees. A fire in your stove may produce heat enough to boil water or produce steam. A fire in a blast furnace will be hot enough to melt iron, while the chemist with his flame and blow-pipe may produce heat so great that it will melt anything with which it is brought in contact. Heat is also produced by the digestion and assimilation of the food which you take into your body; if this were not so you would not be able to live, for unless you can keep the temperature of that body pretty near 98 degrees F.—sickness and death will result. Heat, therefore, is the result of work and also the result of combustion or burning; it is one kind of natural force which has been produced or changed from another kind.

HOW DOES HEAT AFFECT LIFE?

You are well aware that plants which remain out-of-doors during the winter do not grow. This is partly because it is their time of rest, but also because the heat of the air and of the soil are not sufficient for growth. Indeed the cold, or insufficient heat of winter, kills many varieties of plants, while if they are brought into the house, with its higher temperature, they will live. Many plants *do* live in this way and even produce flowers; especially is this true when they have the excellent provision for heat and light which are provided in hot-houses and conservatories. Many animals die from the cold, that is from insufficient heat during the winter, and even fish, which are cold-blooded animals, are sometimes found frozen in the ice. Neither is it unusual for human beings to suffer from excessive heat or insufficient heat, and they, too, may be frozen to death when the temperature is very low. You know what happens when anything that has life is placed in a burning building or in any other place where the temperature is very high. Water at the boiling point will destroy any form of life, high or low. Prolonged high temperature not only destroys life, but it consumes tissues. This happens to food, either animal or vegetable, when it is brought in contact with a hot fire for too long a time, while if the heat is not too great the food is merely cooked by it. Of course it is the duty of a wise and skillful cook to know the degree of heat which is required in preparing food, and if she burns her bread and her meat and the other things which she is expected to prepare for the table, your mothers and fathers will soon find it necessary to hire somebody who will be more careful and intelligent.

High temperature in animals is called fever and when this is ten or fifteen degrees above the heat which is normal or natural the animal dies unless the heat is promptly lowered. When a man suffers with sunstroke his temperature goes up eight or ten degrees and the doctor or nurse applies ice or gives him a cold bath as quickly as possible in order to save his life. The brain and mind and in fact any portion of the body can not do its best when either the temperature of the atmosphere or that of the body is high. You would not expect a man with typhoid fever to do a complicated problem in arithmetic or chop wood, or do anything which required severe mental or physical effort. That is the reason why men and animals do not and can not work so hard nor so long nor accomplish so much during the heat of summer as during the winter, and also explains why the average man who lives in a temperate climate can accomplish so much more than the one who lives in the tropics. The temperature of any living body, whether animal or plant, is greater than when life has ceased. You have doubtless noticed how differently a dead animal feels from a living one. Both heat and cold, that is, high and low temperature, are useful and stimulating to the body under different circumstances. When one is weak and faint, and the surface as well as the interior of the body are several degrees below the normal temperature we revive him and make him feel better and make the blood flow freely to every part by putting a hot water bag at the feet, or over the heart, or at the sides of the body. On the other hand when the temperature is that of winter, and the snow is on the ground and you shovel it away from the sidewalk you feel exhilarated and good natured, and can do any necessary task with twice the ease and pleasure with which you could do it on almost any day in the summer.

It is interesting to note that a temperature which would destroy any form of vegetable life can easily be borne by animals. The fish in the ocean live in a temperature that is persistently low. Animals in the Arctic regions live and thrive in a temperature that is seldom above the freezing point, and there is no place on the earth so cold but that human beings could live there, at least for a time, under suitable precautions. You see, therefore, how very extensive and how very important the question of heat is, and how seriously it concerns every living object.

WE LIVE IN AN ATMOSPHERE WHICH CONSTANTLY CONTAINS MOISTURE.

By moisture we mean, of course, nothing more nor less than water, and need not add much to what has been said in the chapter on that subject. If the water were taken from the atmosphere you would not live. You have read of those who have traveled in deserts where the air is hot and very dry, and they have told you how difficult it was to breathe there, and how wonderfully refreshing a drink of water or water upon the surface of the body was at such times.

Fortunately the two thirds of the globe which are covered with water are constantly giving it to the air by evaporation and thus the moisture is constantly renewed. Sometimes the air gets more moisture than it can hold, and then it falls to the earth, more or less abundantly, in drops, or showers, or torrents. The air is *saturated* when it contains all the moisture which it will hold, and when it gets so much that it begins to drop it has reached the *dew-point*. Excessive moisture in the atmosphere when combined with great heat makes one very uncomfortable, and makes breathing very difficult as you have probably experienced on a sultry day in August. But the moisture is one of the indispensable necessities of all forms of life and if we were obliged to choose between living where it is very abundant and living in the desert where there is none we would quickly take our chances with the former.

CHAPTER XXIII.

Clothing.

COVERING WITH WHICH THE BODY IS PROVIDED.

WE have told you that all living objects, human beings included, are more or less sensitive to changes in the temperature, or the changes in climate, to which the different parts of the earth are subject. Even the plants are included in this rule, and hence we find that nature everywhere aims to furnish protection against such changes, for if it were not so, growth and fruitage and reproduction could not be successfully accomplished. Among the plants we find the seeds covered with a shell or husk, the trunks and limbs of the trees with bark, and the roots with a suitable protective layer or skin. Some of the animals have a skin which is thicker than usual when a greater degree of protection is required, and when this protection is no longer needed the skin is cast off. Other animals are provided with hair which shields them from sudden changes of temperature, for hair is what is called a non-conductor of heat, and this hair which is called fur is longer and thicker when the temperature is low and the air is cold than when the temperature is high. The plumage of birds corresponds to the hair of other animals. Human beings do not have this protection. In warm climates and among savage and uncivilized people no protection is required and the people wear no clothing, but civilized people do not think it proper or decent to go about without clothing and therefore they cover the body, using such materials as will properly protect it. Clothing therefore has for its first great object the protection of the surface and the interior of the body, and for its second the covering, for the sake of propriety and good manners, of all those parts which it is unnecessary to expose. At the same time, good sense and good manners do not require that certain portions of the body may not be exposed when their exposure is essential for the proper performance of necessary tasks. You would not expect a mechanic to be as fully clothed when he is doing his daily work as when he is not working, and it is perfectly proper, in order that he may work freely and efficiently, that he should lay aside his coat and vest, and roll up his sleeves, and perhaps lay aside his hat. Those who work at occupations and in places in which the heat is great must wear even less clothing than this, and it is not unusual for bakers, stokers in the fire-rooms of ships, and workers in mines, in blast furnaces, and in rolling mills to remove also their shoes and stockings and even their shirts in order that there may be free use of the necessary muscles.

CLOTHING AS A MEANS OF PROTECTION.

In considering clothing as a protection from different degrees of temperature or heat we are guided by certain well-known facts in regard to the materials from which it is usually made. I have told you that the hair of animals is a non-conductor of heat; you must also remember that many of the articles used for clothing are also non-conductors of heat; their principal object is not to bring heat into the body or to warm it by their weight but to prevent the radiation of heat from the body and so keep it at a fairly even temperature. In the days when men wore suits of armor of steel and silver and bronze, and coats of mail, they not only had to carry the great weight of this uncomfortable kind of clothing, but they also had to bear the heat which these metals conducted to the body. The principal substances which are used for making the clothing which civilized people wear are silk, cotton, and wool. Wool as you know is an animal product and is the hair of the sheep. A similar substance which is used to a lesser extent is the hair of goats and camels. Silk is also an animal product, being the thread which is spun by the silk worm. Cotton is the fibrous material which is attached to the seeds of the cotton plant. Silk, wool and cotton are spun or woven, after being suitably prepared, into a substance which is called cloth. Before men knew how to spin hair into cloth, they made their clothing from the skins of animals with the hair retained upon them; not only the skins of sheep, but those of other animals. Even at the present time the skins of animals are used for clothing, especially in cold countries, and the beautiful and costly furs which are so common a sight in winter, are made principally from such materials. In the Arctic regions the people have nothing else for clothing but such skins. Furthermore, all people, civilized and uncivilized, use the skins of animals in the form of leather for the clothing for their feet and hands, and not infrequently for their heads. Still the principal substances from which clothing is made are silk, wool, and cotton. Wool and silk are superior to cotton as non-conductors, therefore our clothing is preferably of these substances; especially wool when the temperature is low, as in winter, and cotton when it is high, as in summer. The color of clothing has much to do with its usefulness as a covering to the body. Black and dark colors permit the heat rays of the sun, but not the light rays, to pass through them, while white and the light colors permit the light element in the rays to penetrate them, but not the heat. That is the reason why dark clothing is worn in winter and light in summer. It is hardly necessary to say that clothing should be as light in weight as possible. A heavy woollen garment is more of a protection from the cold than a light one, but it is also more burdensome, and fatigues one to carry it about. That is why we wear heavy overcoats in the winter, but could not wear them with any comfort during the heat of summer. The clothing should be sufficiently heavy at all times to prevent cooling of the body, for if such cooling takes place the circulation of the blood is interfered with, it leaves the surface and accumulates in the organs within the body and is often the cause of disease, especially of those organs which have so much to do with the purification of the blood,—the lungs and the kidneys. The habit which so many people have of letting little children go about bare-legged and otherwise thinly clad in winter is a very bad and unreasonable one. It is often said that this is done for the purpose of toughening children. If all children were equally rugged and well-developed this might be a good excuse, but they are not, and the attempt to toughen them in this way is very apt to result in more or less severe illness. The habit which so many women have of exposing the neck, arms, and chest, especially in cold weather, and at night, when even the protection of the sunlight is wanting, is equally bad and irrational. Those who are teachers of that which leads to health should cry out against these foolish and senseless customs at every possible opportunity. They signify the worship of fashion in its most dangerous form, and are suitable only for savages and insane people who know no better. Clothing which is dry protects the body far better than the same clothing does when wet. When one is exercising vigorously and the blood in the skin is flowing briskly the discomfort of wet clothing is not very great, but when the exercise is over and one sits down quietly the discomfort is soon noticeable, whether the moisture in the clothing proceeds from perspiration or from outside the body. The wet clothing quickly takes the heat from the body and a sense of chilliness or coldness soon follows. Such clothing should therefore be removed as soon as possible, the body briskly rubbed, and warm and dry clothing put on. It will often be found useful to administer heat internally, on such occasions, a bowl of hot tea or ginger tea or some other suitable hot drink being given. These measures will seldom fail to restore the blood current to its proper channels and bring the heat of the body back again to its normal condition. Neglect of these precautions has often resulted in a severe cold or cough or pneumonia, and death. Of course it is not always possible to make this change of clothing, in which case an effort should be made to dry one's self before a fire, and if this is impossible one should wrap himself up in a heavy blanket or other suitable bed clothing. Even if disease should not follow such exposure to cold and wet, there will usually be pain and stiffness of the joints and muscles and very great discomfort. Such discomfort is greater when cotton clothing is worn than when it is woollen, hence the greater necessity of immediately changing wet cotton clothing. The clothing, in most cases at any rate, should fit the body loosely enough to permit free action of the muscles in walking, running, and performing the ordinary duties of life. You have all seen athletes, ballplayers, and oarsmen and know that they wear no more clothing than they can help, and that which they wear fits them very loosely. You have also probably noticed that after any great exertion they cover themselves with a coat or other heavy garment, or they have a brisk rub-down, or they take a bath, and then put on dry clothing, in other words they take just those precautions which I have advised you to take after your clothing has become wet from any cause whatsoever.

How irrational and contrary to nature is the Chinese custom of bandaging and fettering the feet of infant girls; equally so is the custom of binding down the legs and bodies of little children to prevent them from being bow-legged, which is a very common custom in the countries of southern Europe. Similarly foolish are the customs of wearing tight shoes, shoes with very high heels and very narrow toes, of binding the waist with tight clothing, and of wearing tight skirts, fashions which are at the present time very prevalent among people whose intelligence should teach them better. How different were the customs of dress among the civilized nations, two thousand years ago, especially among the Greeks and Romans. The garments which they wore next the body fitted it snugly enough to retain its heat, while the outer garment was loose and flowing, permitting the greatest freedom of muscular action. Instead of tight fitting shoes, the feet were merely encased in sandals. The body therefore had every possible chance to develop, and since they also gave the greatest attention to bodily exercise, it is not strange that their physical development should have been far better than ours notwithstanding our boasted knowledge, and our superior methods of treating disease. Living so much of the time in the open air as those people did, taking so much exercise, and wearing such sensible clothing, they were free from many of the diseases which are common at the present time and therefore they had very little use for doctors.

CLOTHING FROM THE STANDPOINT OF BEAUTY.

Clothing serves another useful purpose in ministering to the sense of beauty which ought not to be neglected. A garment need not be ugly in order to be useful and comfortable. It is not necessary that it should follow any style which is unreasonable and ridiculous; it is not beautiful merely because it is fashionable. Beauty clothes most of the things in nature; the colors of the plants and the flowers add to our enjoyment of their graceful forms. Many of the animals are clothed in robes which men envy and take away from them to adorn their own houses or their own bodies. The birds charm us not only with their song and their freedom of motion, but with their plumage and too often they are robbed of life and plumage to gratify the vanity and love of adornment of human beings. What can be more gorgeous in color and form than a peacock with its tail fully spread! How beautiful is the clothing of many of our smaller birds, the cardinal bird, the oriole, the indigo bird, the thrush, the robin, and many others. Among the tropical birds are many whose plumage is almost dazzling in its brilliancy of red, green, blue, and yellow.

We have referred to the methods of clothing among the Greeks and Romans. They were the most highly cultivated nations of ancient times and were particular not only about the protection which they derived from clothing, but also as to its beauty. They made use of rich materials, silks, and velvets and wool, when they were able, and while white was more frequently used than the bright colors on account of its adaptability to a warm climate and bright sunshine, they also used purple, and red, and green, and other colors. Purple was a favorite color with them, and many of their finest fabrics were of this color, the dye with which it was colored being obtained from a shell fish which was procured in great quantities from the shores of the Mediterranean. Not only were the women richly clothed, but the men also spent large sums of money and a great deal of time upon their clothing, probably much more time than is given to such subjects by men nowadays. You all enjoy the beauty of a military parade and one of the chief features of such a parade is the brilliant clothing which is worn by those who take part in it. One of the principal attractions of the plays in the theaters consists in the variety and beauty of the clothing which is worn by the actors, and in the processions of the church we are often impressed quite as much by the imposing appearance of the robes which are worn by the priests and their attendants as by the other and more important features of the ceremony. Almost everybody likes to see a well-dressed person, whether it be a man or a woman. We are particularly pleased when the women whom we know are dressed attractively and becomingly, and there is a good deal of truth in a remark which a beautiful woman once made to the writer—"it is a woman's duty to look pretty." Beautiful clothing is usually expensive, but it does not follow that the most expensive clothing is always the most beautiful. You have doubtless seen people wearing costly garments and jewels, and wearing them with such bad taste, that you are impressed more with the cost and expense of the things with which they have covered themselves than with their beauty or their appropriateness. They are like the "jewel of gold in a swine's snout," entirely out of place. Those who attend the courts of kings are frequently clothed in great magnificence. But even at courts this magnificence and extravagance of dress is practised far less, at least by men, than it formerly was. During the reign of Queen Elizabeth in England costly clothing was especially fashionable among the men by whom she was surrounded. One of her courtiers was a great and very wise man, but also a very vain one, named Sir Walter Raleigh. It is said that he was accustomed to spend thousands of dollars upon the diamonds in his shoe buckles, and thousands more for the silks and velvets and plumes of his clothing. He was captain of the Queen's bodyguard, and used to parade in a dazzling suit of silver armor, while another of his suits of clothes was covered with jewels, and is said to have cost $150,000. The Duke of Buckingham, who was the favorite of the English King James I, is said to have had a suit of jeweled clothing which cost him about two millions of dollars, as values are at the present time. This would be considered very lavish magnificence in clothing even by the rich and extravagant millionaires of our day.

BEAUTY OF CLOTHING DOES NOT NECESSARILY MEAN GREAT COSTLINESS AND SHOWINESS.

There is nothing more charming than a joyous, healthy, becomingly dressed child. If the child is covered with spangles and gew-gaws it may excite attention, and indicate that much money had been expended upon him, but most people would care little for his clothing, though they might care a great deal for the child. A young girl or a woman with simple but becoming clothing may be far more attractive than one who is clad in silks and velvets; indeed, most women when simply and inexpensively clothed are apt to draw attention, if they have beauty of face and figure, more effectively than if they are overdressed, for in the latter case it is their clothes which excite attention and criticism, while the beauty of the individual may be overlooked. Still less desirable is gaudy and showy clothing upon a man. We call a person who is thus attired a fop, and because he draws attention to his clothing we are very apt to think there is nothing else about him which is worth considering. Costly and showy clothing upon anybody, whether man, woman, or child almost invariably indicates vanity and excessive self-esteem, and these are qualities which are not worthy of being encouraged, and which we would urge you to avoid at all times.

CLOTHING AS A MEANS OF COMFORT.

If a garment is ever so handsome and costly, and yet does not protect you from the cold, of what use is it? If it is to be worn in hot weather and is so heavy and burdensome that it makes you perspire and irritates you, or if it is so tight that you can not move about freely, it will give you very little pleasure. It might be the robe of a great office, and it might be a great honor to wear it, but most people would be glad to lay it aside as quickly as possible. The object of clothing is, therefore, to make one comfortable, and if your tailor provides you with clothing which is uncomfortable, you will soon find it necessary to exchange him for one who can suit you better. The fit of clothing is therefore a not unimportant consideration; it must not bind you and prevent freedom of breathing and motion, and it must not have creases and wrinkles where they do not belong. It must be sufficiently loose so that you may do what you are called upon to do without being continually reminded that your clothing is uncomfortable. Do not think these things are unworthy of your attention, for they sometimes have great influence upon the disposition, and even upon the health aud character.

CLOTHING IN ITS RELATION TO HEALTH.

In a climate which is very changeable, the subject of clothing can not help having an important bearing upon the health. The heat today may be almost intolerable, and tomorrow there may be a frost or a snowstorm. Remember that the temperature of the body must be kept uniform in order to have good health, and that the first object of clothing is protection to the body. If, therefore, such a sudden drop in the temperature as was suggested should take place, the clothing which is a protection today would be very inadequate tomorrow. The result of such sudden changes is a great deal of sickness, especially among children and aged people, and others who are more or less delicate, and much of this sickness could be avoided by suitable changes in the clothing. In locations which are frequently visited by sudden changes, woollen clothing is much more of a protection than cotton, because it is a better non-conductor. Even very light woollen clothing may be worn in warm weather, and it is far safer for sensitive people that they wear woollen throughout the year. Of course, clothing which is worn during the day should all be removed, and a woollen or cotton night gown worn during the night. The bed clothing should be sufficient to prevent chilliness during sleep, and it is well to remember that during sleep the temperature of the body is somewhat lower than during the hours of activity; hence the greater need of protection from clothing. It seems hardly necessary to say that the clothing of the sick, as well as their bed clothing, should be frequently changed. Cleanliness of the clothing at all times is a matter of great importance. When one is at work it is often impossible to have either the clothes or the body clean, but when the day's work is over the time for cleaning up has arrived. Clothing frequently bears the germs of disease; hence the necessity not only of suitable changes, but of careful cleansing and disinfection after exposure to such disease.

CHAPTER XXIV.

Care of the Skin, Hair, Nails, Hands, Feet, and Teeth.

ONE of the most valuable possessions of every boy and girl is good health. Education makes you useful and attractive citizens, for boys and girls are citizens just the same as men and women. Books and toys give you pleasure. Kind parents and comfortable homes are great blessings. But you may have all these and still be unable to enjoy or to use them because you have not health. Perfect health means that every organ of the body is doing its own work. Do you know what we mean by an organ of the body? We mean a part of the body which has its own definite work to do, as the skin, heart, lungs, stomach, and so on, and when each organ does its own work perfectly they all work in harmony and the whole work of the body is accomplished.

This work of the body is to keep health, just as the work of a watch is to keep time and the work of an engine is to produce power. So a healthy organ is needed to do its work perfectly. An engine and a watch need care and sometimes repairing. The same is true of the skin. It needs care all the time, and that is your work, and then when it is diseased, which means that it is not doing its work well, it needs your care more than ever, and a physician is needed to help you. To do your part in taking care of the skin you must know something about what it is, what it is for, how it looks, and how it feels in health and disease. You look at it constantly, but you rarely stop to think about it. But now you are looking at it because you can not understand what care it needs unless you know something about what it is.

What is the skin? It is an organ of the body which is essential to life. It covers the whole surface of the body, not just lying on the tissues beneath like an envelope or a glove, but its under surface is interwoven with all these soft tissues, and it is intimately connected with the internal organs through the blood vessels and the nervous system. It consists of elements, or parts, called cells, and these are arranged in three layers—the epidermis, also called scarf-skin, cuticle, or outer layer; the corium, also called true skin, derma, or inner layer; and beneath this, the subcutaneous connective tissue, or fat layer. These layers are closely fastened to each other and to the tissues beneath.

In the fat layer, the tissues are loosely arranged and fat-cells lie in them. This fat makes the body more beautiful because more rounded; it acts like a cushion to protect the body from external injuries; and, as it is a poor conductor of heat, it prevents too great a loss of body heat. This fat is abundant in some parts of the body and less abundant in others. Upon these fat-cells and closely connected with them, lies the corium, which is made up of fibers or bundles of connective tissue, and imbedded in these fibers are the blood vessels, nerves, lymphatics, hair-roots, sweat glands, and sebaceous glands. The corium is a dense, fibrous layer, and it gives to the skin its strength and elasticity. It is thick on the back, the palms of the hands, and the soles of the feet, and thin on the face, eyelids, and other delicate parts. This is the part of the skin of an animal which is used to make leather, which, you know, varies all the way from kid to sole leather.

Closely connected with the corium, the upper surface of which is studded with tiny elevations, called papillæ, lie the cells of the epidermis. These cells fill in the depressions between the papillæ, and cover

over the tops of the papillæ, and in this way the surface of the skin is made smooth and even. The external or outer cells of the epidermis are flat, dry, and hard, and are constantly worn away by friction and change of temperature. Beneath these, and next to the corium, are the soft, developing cells which supply the new cells to take the place of the dry, hard ones which are rubbed off.

In the deepest of these soft cells are deposited tiny, colored granules, called pigment. This pigment makes the color of the skin of the various races differ. The black skin, the tawny skin, and the fair skin depend upon the amount and color of the pigment. So you see the skin is a collection of cells wonderfully arranged that they may accomplish a definite purpose.

What is this purpose, or what is the function of the skin? First, for protection. The cushion of fat, the flexible, elastic corium, the hard, dry cells of the epidermis, all unite to protect the soft tissues beneath. Then the abundant nerve supply makes the skin the principal seat of the sense of touch, or tactile sense, as it is called, and by this the body is protected from extremes of heat and cold and from external injuries. A second use is excretion—that is, the skin acts as the lungs and kidneys do, and carries off waste matter. This is done through the sweat glands. These little glands are acting continuously, night and day, but the quantity poured forth is so small that we do not see it. After exercise, or when the body is very warm, this perspiration is increased in quantity and forms, on the skin, little drops which are plainly visible. As soon as this fluid is poured out upon the surface of the skin, the air causes it to evaporate, or dry up, and this process, which is called evaporation, regulates the body-temperature. The body needs the skin to excrete waste matter, and by this excretion to control the temperature.

A third use is to make the body more beautiful.

The bones and muscles give form and strength to the body, but the skin gives a softness and finish, which add to its beauty. The rounded, smooth surface, soft but firm with its delicate pink coloring, is only found when the skin is in perfect health. When diseased, the beauty is gone, for hard, dry, pale skin, with deep wrinkles, does not conceal the irregular bones and muscles beneath. So you see that the skin has a great work to do in protecting all the other organs of the body and in working in harmony with them.

To do this work well every part must be kept healthy by good care. The cells must be perfect. The blood vessels must carry pure blood to the skin to nourish it, and must carry back the impure blood. The nerves must feel the slightest changes in temperature or pressure. The sweat glands must pour forth their fluid to purify and to cool the surface, and the sebaceous glands must pour forth their oily fluid to soften the skin and hairs and also to cool the surface.

The skin is to protect the body and you are to protect the skin. All the time, you must be on the alert to see that it is shielded from unnecessary injury. This injury may come from within, as when the other organs fail and throw extra work upon the skin, or from without, as bruises and burns, dirt, germs, and the bites of insects. To prevent injury from within, the digestive organs, the stomach and intestines, must be kept in perfect condition. This you can do by proper diet. The food must be nourishing, varied, and well cooked. Rich, fried, and highly spiced foods interfere with digestion, and soon you have no appetite for the nourishing foods, but wish only the unwholesome ones. A healthy boy or girl should have a good appetite for breakfast, luncheon and dinner. Food which is unsuitable and taken between meals is often the cause of sallow, rough skin, and of troublesome skin diseases, as hives, eczema, and acne with its pimples and blackheads.

Besides food, exercise has its good effect on the skin. A brisk walk, skating, dancing, running, games, and all out-door sports bring the blood to the surface and increase the perspiration. For little children, playing their own games is far better than walking with an older person. In this way, they will seldom reach the point of overtire. This health-giving exercise will make you tired, and this brings us to the third point, rest. Early to bed, early to rise, and plenty of fresh air in the sleeping room are the best medicines for fatigue, and they take the place of many bottles of medicine. Nourishing food at regular hours, exercise stopped before the point of tire is reached, and long nights of sleep in well ventilated sleeping rooms are then very necessary for keeping the skin firm, smooth and rosy.

To prevent injury from without, clothing and bathing are most important. Too thin clothing causes a chilling of the skin and makes it red and harsh, and it may cause more serious injury, as in severe frost-bite. Too heavy clothing keeps the skin constantly moist with perspiration, and it is then easily bruised and infected. The proper clothing should be clean, soft, and loose, and should vary in weight according to the temperature. Especially is this true in young children, for their skin is very sensitive and free motion and free circulation are needed for its safety and for the proper development of the organs beneath. Bathing cleanses the skin of dust, germs, the secretions from the sweat and sebaceous glands, and the odors caused by the decomposition of the perspiration.

There are many kinds of baths, but the one best adapted to keeping the skin sound is a warm tub bath quickly taken, immediately upon rising in the morning. If a tub bath is inconvenient, a warm sponge bath will keep the skin perfectly clean. For some, the cold bath is invigorating, but unless a good reaction follows after the brisk rubbing, it is a source of danger. A pale skin, blue lips or nails, and chilly feelings indicate a poor reaction, and that means that the cold bath is unwise. A hot bath may do as much harm as a cold one, because of its depressing effect. A rough wash cloth is needed for its stimulating action on the skin, and because of its roughness and the ease with which it can be kept clean by washing and boiling, it long ago took the place of the old-time bathroom sponge. A sponge takes in dust and germs almost as readily as water, and it is impossible to thoroughly cleanse it.

Very little soap and only the purest should be used, for it removes too much of the natural oil of the skin and leaves it dry and harsh. Medicated soaps are unnecessary, and often do harm. For little children, the bath should be given in a warm room, the rubbing should be very gentle, and the towels soft. A healthy skin needs no powders and no ointments. When there is redness and irritation in the folds of the skin, this should be gently dried without rubbing and then lightly dusted with a pure unscented powder.

As a protection against the spread of disease, you should have your own toilet articles—towels, washcloth, soap, and comb and brush, and the towels, the soap, and the combs in public toilet rooms you should never use.

Other kinds of baths, as the vapor, steam, Russian, and Turkish, are of distinct benefit in certain cases, but they may do much harm, and are best taken only on the advice of a physician. Again, there are medicated baths, in which sea salt, boric acid, soda, bran, sulphur, and numerous other drugs are used for their soothing or irritating effect on the diseased skin, but these, too, are unnecessary for the healthy skin.

Sea bathing gives pleasure and stimulation, but it also has its dangers. A short swim or battle with the surf should be followed by a good reaction, and any suggestion of chilliness should be a signal to come out of the water, to dry the body briskly, and to take active exercise until a feeling of warmth has returned. The beating of the waves on the body is the cause of the stimulation and of the good that is gained, but if this is kept up too long, there is danger of exhaustion. Another danger is the damage which may be done to the ears by the force of the surf and by swimming too long under water.

There is nothing mysterious about skin diseases, for they simply show you that you have not sufficiently protected your skin from poisons from within the body or from injuries and contagion from without. You have been ''off guard'' and have neglected the simple rules for taking care of the skin. Remember that the healthy skin needs no medicines and that the diseased skin needs the most careful treatment with the right medicines, for often a very trivial disease is changed to a serious one by neglect and bad treatment.

THE HAIR.

The hair is called an appendage, or part, of the skin, and it is formed by a special modification of the same cells which form the epidermis. The roots dip down into a fold or pocket of the epidermis, called the hair follicle, and this follicle rests upon the hair papilla, which is the part from which the hair grows. Hair is found on nearly all parts of the body, except the palms of the hands and the soles of the feet, and it varies in length, thickness and color. Its principal use is to make the body beautiful, but the hair on the scalp also gives protection from cold and blows. The glossy, long hair, the eyelashes, eyebrows, and the fine, downy hair on the face and body, all contribute to the finish and beauty of the skin.

But the hair on the scalp is of particular interest to you because it needs your special care. This hair is short, soft, and fine in little children, but, as they grow older, it grows long and coarser. Among most races, it is customary for the women only to allow the hair to grow long, but among a few races the men leave both the hair and the beard uncut.

The hair is affected, just as the skin is, by diseases of the internal organs and by diseases which belong only to itself. Severe illness and prolonged fevers make the hair thin and lifeless, and this gives rise to the mistaken idea that it should be cut short during convalescence. This is unpleasant and unnecessary, for with good care and returning strength, the hair will regain its former gloss and thickness. Old age thins and grays the hair, but this is a gradual change and not a disease. There are a few cases of sudden whitening of the hair, caused by grief, anxiety, or terror, which are well authenticated and often cited, and they are of interest, because they show the effect which the nervous system can have on the hair.

When the scalp and hair-roots are diseased, the hair becomes thin, loses its luster, changes its color, and all its natural beauty is gone. It is better and easier for you to keep your hair in good condition by the right kind of care than it will be for you to get it well after you have ruined it by wrong methods. Too frequent washing, hair tonics, hair dyes, and the modern methods of hair dressing with rats and false hair are some of the causes of disease. Going bareheaded in the bright sunshine makes the hair brittle and causes it to fall out, and the prolonged use of heavy, unventilated hats is also a cause of baldness.

In the proper care of the scalp, cleanliness is of the greatest importance. This means cleanliness of the scalp and of the comb and brush as well, for dirt, germs and pediculi, or lice, can not stay long on the scalp without attacking it. Warm water and a pure soap are all that are needed for cleansing the scalp and hair. Hot water and strong soap remove all the natural oil and leave the scalp hard and scaly, and the hair dry and lifeless. After rinsing with clear warm water, the scalp must be thoroughly dried. A healthy scalp needs washing about once a month and it needs no hair tonics and no ointments.

In dressing the hair gentleness is very important. Loose braiding and twisting prevent injury and add to its beauty. Careful combing, and brushing with a moderately stiff brush improve the circulation and thus nourish the hair. As long as the hair papilla is healthy, the hair drops out and grows again, but a long-neglected, scaly condition of the scalp, called dandruff, will interfere with the nourishment of the hair, and, if left untreated, will finally cause baldness. Constant daily care will prevent disease, and giving up wrong methods of washing, treating, and dressing the hair, and using the right kind of cleanliness, gentleness, brushing, and hair dressing will often improve thin, unhealthy hair. But if there is real disease of the scalp, it is just as important that it should be treated with the right medicines as when disease attacks any other part of the body.

THE NAILS.

Another appendage, or part, of the skin is the nails, and these, like the hair, are a peculiar modification, or arrangement, of the cells forming the epidermis, or horny layer of the skin. The root of the nail, which is the part from which it grows, is imbedded in a groove of the skin and its under surface is fastened to the corium or lower layer. The blood vessels in the corium beneath the nail give it the pink color in health and the blue color which is seen when one is cold or faint. The functions, or uses, of the nails are protection and beauty. They protect the soft cushion at the tips of the fingers and toes from injury, and they form a firm support for this cushion when the fingers are used in picking up objects, or the toes, in balancing the body. They correspond to the claws in animals, but the nails give delicacy of touch and the claws give strength to tear and destroy.

The pink, smooth, glistening surface of the healthy nail is very different from the discolored, rough, dull appearance of a neglected or diseased one. Its growth depends upon the health of the matrix, or root, and upon the health of the whole body. Bruises and infections, or poisons, of the root and of the sensitive skin about the nails change their shape and growth. So, also, diseases of the internal organs make them thick, uneven, rough, dark colored, and easily broken.

To keep them in a healthy condition requires constant care. You must brush them with a soft nail brush, warm water, and but little soap; dry them gently but thoroughly; trim the free edge with scissors at regular intervals; and remove the dirt from the free edge with a blunt nail-file, taking care not to roughen the under surface of the nail. This daily care will preserve their natural beauty and prevent disease. These are simple measures, but they are often carelessly done or carried to extremes and there result deformity and suffering. Using strong acids, cutting the fold of the skin about the root, and loosening this skin with sharp instruments often cause serious injury.

From neglect, the sensitive skin about the nails becomes dry, cracked, and poisoned with germs. Then the scalp or other parts of the skin are scratched and the germs are carried from place to place. The free edge should be trimmed so that it is kept even with the tip of the finger and toe. A very painful condition of the toes, called ingrowing nail, is caused by cutting down at the side of the nail and by pressure from shoes which do not fit the foot.

The nails are made to make your hands and feet more useful and more beautiful, and the result depends on the care you give them. Gentleness, cleanliness, and carefulness must take the place of biting the nails, harsh treatment, and neglect if you would keep them free from disease.

THE HANDS.

Each separate part of the body is a wonder and a delight to study, because of its perfect mechanism. One of the most wonderful and, oftentimes, least appreciated is the hand. It is formed of a number of small bones, some long and others irregular in shape, which are joined together by ligaments and covered over with muscles in such a way that there is great freedom of motion. Each part has its own value in the work of the hand. The fingers vary in length that they may fit the hollow of the hand and the thumb can be moved easily in all directions. The smallest baby hand can grasp an object, but the ability to use it for some definite purpose comes only with training.

The skin of the hand is also adapted to its uses. It is soft on the back of the hand and firm and dense on the palm, where it is more liable to injury. At the ends of the fingers, it is modified to form the nails, which give support and protection, and in the skin, at the tips of the fingers the nerves of touch are very numerous and highly developed. This arrangement of the nails and nerves gives to the fingers power to pick up small objects, and these various parts make the hand capable of great training. It reads for the blind, plays for the musician, puts into form the inventions of thought, expresses emotions by gesturing, and is needed for almost every act from the most trivial to the most important.

The brain and the hand work together, and they are the most valuable tools which a human being owns. Countless things are done by the hand each day, but when perfect and finished work is done, it is always the result of long training—that is, repeating the same thing over and over again and striving each time to make it more perfect.

Character is shown in many ways—by the face, speech, actions, and by the hand. An ill-kept hand means carelessness, but a hand that is soiled by good, honest work is never a disgrace. A large, strong hand and a small, delicate one are equally important for their own particular work, and both are capable of showing gentleness and care. A hand which is neglected is neither useful nor beautiful, for injuries stiffen the joints and cold and dirt roughen the skin. The dyes and chemicals used in some kinds of work injure the skin and cause very painful diseases. Chapped hands are the result of too hot water, too much soap, and careless drying.

The hands must be kept clean with warm water, a little pure soap, and a moderately soft nail brush; then dried thoroughly with a clean, soft towel and protected by warm gloves during the cold weather. The slightest injury of the skin should be healed without delay, for germs are always present and a neglected infection may burrow deep into the hand and arm and cause stiff joints or even loss of a finger, a hand, or an arm.

THE FEET.

The bones of the foot are similar to those of the hand, but they are arranged to answer a different purpose. Those of the hand give great freedom of motion, while the foot bones give firm support to the erect body and elasticity to the step. In this the hand and foot of man differ from those of animals and contribute much to man's superiority. The bones of the foot form an arch and changes in this arch are responsible for much suffering.

The condition of the feet influences the health of the whole body and the usefulness of the individual. There is no pleasure in walking, running, skating, or dancing if the feet hurt, and the feet will hurt unless they have proper care. They must be protected from injury, they must be kept clean and soft, and they must be properly clothed.

The baby's foot is growing, the shoes and stockings must be large enough to allow the bones and muscles to develop without restraint. Nature knows best how large a foot the baby will need when grown up, and, if she is assisted by proper care and dressing, the foot will grow to a size which is suitable for the size of the body, and because of its health and usefulness it will add perfection and beauty. The Chinese nation, for centuries, strapped the feet of the little girl babies. This strapping pressed the bones out of their right position and interfered with the development of the muscles, and the result was deformity and loss of elasticity in walking, besides great suffering for the babies.

Sometimes, we see girls and women who think only of the size of the foot, and by wearing too small a shoe, they throw the bones out of place and have an unshapely and ugly foot. When the arch of the foot is broken down the sole becomes flattened and pain is felt not only in the foot, but also in the leg and back. The constant distress affects the nervous system, and then the general health, and makes one unfit for work or for pleasure. This condition, called flat-foot, is often caused by the strain which is kept up by continued standing, especially among children who are growing, and who are doing work which is too heavy for them. Or it may be caused by jumping on hard ground, in outdoor sports.

Other troubles, which are better prevented than cured,, are bunions, corns, and calluses. These are very painful, and they are caused by neglect and ill-fitting shoes. Too large a shoe will do almost as much harm as one that is too small. The shape of the shoe should follow the natural lines of the foot; and the sole should be thick enough for protection and support, and, at the same time, flexible so that it bends easily; the heel should be flat and of moderate height.

Many children like to go barefoot. This does allow the foot to grow without hindrance, but the danger of infection, bruising, and cold are greater than the advantages, and sandals or shoes are safer. The stockings are almost as important as the shoes. They should be soft, clean, and of moderate weight, and they should fit the foot. The care of the skin is very simple but very necessary. It consists of bathing the feet, each day, in warm water and rubbing until thoroughly dry.

THE TEETH.

Good health and good teeth go together, and each one is dependent on the other. The process of digestion begins in the mouth, where the food is changed by the grinding of the teeth and by the action of the saliva. If the teeth have been lost or decayed, the food is not properly chewed and digestion is interfered with. The functions, or use, of the teeth is for masticating, or chewing, the food, but they also contribute to the appearance of the face. Unclean, discolored, irregular teeth are unsightly and disfiguring, and an absence of teeth allow the cheeks and lips to sink in.

The teeth are a part of the bony system, and begin to appear when the baby is about six months old. These are called milk teeth and beneath these, in the gums, lie the beginnings of the second set, called the permanent teeth. This second set grows very gradually and, when the child is about six years old, the roots of the milk teeth are loosened by the pressure of the little teeth growing beneath them. These then fall out and the permanent set grows in to replace them. If the little baby has not had the right kind of food, or if it has had serious illness, the teeth may be late in appearing, or they may be irregular and ugly in shape.

The kind of teeth varies much in different individuals. But their condition is more important than their shape, for clean, healthy teeth every one can have, but every one can not have perfect ones. When the permanent teeth are lost, new ones do not replace them, so it is very important that these should be protected from injury and decay. Biting threads and hard substances, pulling corks, and cracking nuts break the enamel and open the way to decay. Some medicines injure the enamel unless taken through a glass tube or rinsed off immediately.

The body of the tooth consists of ivory, or dentine, covered by a thin substance called enamel. The cavity within the body of the tooth is filled with a soft, pulpy substance containing blood vessels and nerves. When the enamel is destroyed by injury or decay, it is not replaced, and this leaves the more sensitive body unprotected.

Decay is caused by acid saliva and by the action of bacteria. The mouth is filled with many kinds of bacteria, that is, minute forms of vegetable life. Some are harmless and others are harmful. When from indigestion, the saliva becomes unhealthy and acid and the particles of food are allowed to lie between the teeth, the number of harmful bacteria is much increased, and they attack the enamel, the body of the tooth, or the gums. These diseased or decayed teeth cause bad breath, neuralgia and often disfigurement. Ulcerated teeth have caused deafness and general poisoning of the whole body.

All this suffering can be prevented by care. The milk teeth should be just as carefully cleansed as the permanent ones. A moderately soft brush, with cool water and a pure tooth powder or paste, thoroughly used on the inner and outer sides as well as the crowns of the teeth, will remove all the loose food and will keep the gums free from germs. This thorough brushing and rinsing of the mouth are particularly important at bedtime.

The food, which is fastened firmly between the teeth must not be removed with a toothpick or any metal instrument. Dental floss, drawn between the teeth, will remove it much easier, and without injuring the teeth or the gums. An injury to the gums, just as to the skin, gives an entrance for the germs, which are always present, and then follow infection and suffering. Certain foods, as too much sweet or fried foods, cause indigestion and so change the saliva and injure the teeth. While other foods prevent the growth of strong, healthy teeth, because they do not furnish the proper nourishment to the bony sytem.

Besides the daily care, the teeth must be thoroughly cleaned by a dentist, at regular intervals, and all cavities must be filled. Even crooked teeth can be made straight if the dentist begins when the child is young, and those that are past repair must be replaced. Since the general health, the power of the mind, and oftentimes the future of the child are influenced by the health of the teeth, every child should be taught how to care for them and what will be the result of neglect.

CHAPTER XXV.

Importance of Regularity of Habits.

ALL THE MOST IMPORTANT EVENTS IN THE UNIVERSE TAKE PLACE ON SCHEDULE ARRANGEMENT.

WHEN you read in the Foundation Library the volume devoted to Astronomy, you will find that although the heavenly bodies are so far away that the mind can hardly grasp the idea of their remoteness, the astronomers who have studied their motions, have ascertained that each moves in a particular direction at a known rate of speed, and although there are so many of them, they never run into each other. Their habits are perfectly regular, unless perhaps we except the comets, and astronomers have usually predicted with accuracy what is to be expected from them. In the great events of the earth on which we live there is also a fixed and dependable regularity; summer follows spring; autumn follows summer; winter follows autumn. Because the farmer knows this he understands how to govern his work, and he looks for the harvest, more or less abundant, as the regular result of the planting of the seed, and the care of the growing crop. So, too, night follows day, rest follows labor, age follows youth; all these things indicate regularity of action, for if they were not regular you can see how all our calculations would be upset and deranged, and what an unfortunate effect it would have upon life and action. When we come down to the ordinary affairs of everyday life we see how necessary it is that this same plan of regularity which runs with more or less certainty through nature's processes, should be followed. A man starts his business at seven or eight o'clock in the morning, and expects all his employees to be there on time. If one of them is late it may interfere with the proper running of the business for an hour, or perhaps for the entire day. You know there are certain wheels called cog-wheels in which there are projections or points on one wheel which fit into depressions on a wheel which works in connection with the first one; now if a projection on the first wheel is broken off, or does not fit accurately in the depression or hollow in the second, it may cause a stoppage of all the machinery which is dependent on the running of these two wheels, and perhaps throw an entire system or plant into confusion. That means that the habit of regularity in this cog-wheel is broken, and you see how important regularity is in this instance. Almost everybody travels a great deal, nowadays, by trains or steamboats or both. Railroads are not always as punctual as they should be; accidents or carelessness may prevent their running on schedule time. But in most cases the schedule is meant to be followed every day and on every trip. When you travel you take it for granted that the train or the steamboat is going to leave on schedule time; should you count on the train being five minutes late, and time yourself accordingly, you are likely to ''get left'' and the train or boat to go on without you.

IMPORTANCE OF REGULARITY IN POSITIONS OF TRUST AND RESPONSIBILITY.

Let us see how this matter applies in the positions of trust and responsibility in which men are placed, and in which they are expected to be ''on time'' and ''on hand'' when wanted. Some of the writers of history say that Napoleon lost the Battle of Waterloo because Marshal Grouchy did not come up with his reserve troops at the time and place where he was wanted and expected. That may or may not be true, but it will illustrate the importance of being depended upon by those who trust you, the point which it is desired to bring out. This is not the only case in which a great battle has been lost, and perhaps the fate of a country decided, because somebody who was depended upon and who perhaps had previously given good evidence of trustworthiness, failed to "make good" at an important moment. You have seen the switch-towers in railroad yards, and the rows of levers which must be pulled or pushed at the proper moment in order to let the trains pass through on the right tracks. Do you suppose that a man would be placed in one of these towers who was not regular in his habits in every sense of the term, who was not faithful, and who could not always be trusted? Some men have been faithful in such positions even unto death, even to being stricken down without a moment's warning. A doctor who has a very sick patient often says as he leaves the house—that he will return at a certain hour. When the hour arrives he is expected to appear, and if he fails to appear, those who care for the sick are keenly disappointed; if he repeats this experience very often, it is evident that his statements are not to be depended upon, that he is not systematic in his habits, and therefore is not desirable. These different forms of regularity which have been mentioned can perhaps be properly classified under the head of punctuality.

REGULARITY OF HABITS FROM THE MORAL STANDPOINT.

Regularity of habits also refers, as you very well know, to correctness and integrity in behavior. If a man goes habitually to horse-races, if he gambles at such places and elsewhere, if he gets drunk, or if he gives way frequently to bad temper, swears, or uses vulgar language, you do not hesitate to say of him that his habits are irregular. When a man steals money from his employer, the reason which is often given is—irregular habits. He had become so much interested in betting or gambling or in some other form of vice that either his mind became perverted, and he did not realize the wickedness and crime of his acts, or took the chances that his sin might not be discovered. We have in this country a great many men who are called captains of industry who have vast interests under their control, and who employ large numbers of men, some of whom have positions of great responsibility. These men are usually very shrewd and keen. Do you suppose that one of them would place in an important position a man whom he knew was in the habit of drinking and gambling, and doing other things which are bad? Or if he found that one of his trusted employees was guilty of such conduct, is it likely that he would continue to employ him? He might give the man another chance, showing him the folly of his conduct, and warning him of the disgrace and punishment which would result if he did not correct his habits. But if the man persisted in his evil course, his employer would be foolish and blind to his own interests if he did not discharge him, for when a man has the gambling habit, or the drink habit, the temptation to take what belongs to others, is often very strong, too strong to be resisted. Not only does loss of position and the loss of confidence of those whose confidence is most desirable, result from such irregular habits, but in many cases life itself is wrecked by them. That shrewd observer of life and conduct, the late lamented Josh Billings, once said "when a man begins to go down hill, it seems as if all creation was greased for the occasion." Slipping is easy, but getting back after you have slipped away from your position, whatever it may be, in which you enjoyed the confidence of those around you, is very, very difficult.

REGULARITY MEANS DEPENDABILITY.

A boy or a man who is always "on hand" when he is expected, who always keeps his word, soon obtains the confidence of those who have dealings with him, and if there is important work to be done, he is the one who is selected to do it. His employer knows he can trust him, and when he places a task in his hands he does not worry about the result, for he feels sure that it will be properly done if it is possible to do it. These are the men who become strong and useful, and who accomplish the important things in life. We all desire or ought to desire to do as much work and as useful work as we can while we stay here, and be assured, we are most likely to do this if we put all our thought and energy into what we are doing, and acquire the habit of doing things thoroughly; shirking nothing that is plainly our duty; and doing our tasks as well as we can, not once, but all the time. Now the habit of doing things in this excellent way is best formed in childhood and youth. You can easily bend in any direction a sapling that is three or four feet high, and you can fasten it so that it will grow in that direction, but if you wait until it is twenty feet tall, and several inches thick, it will be very difficult to give it a new direction, and in many cases it will be impossible. Nothing helps in the development of character like starting right, and listening to the advice of those who have had experience, and are glad to direct your feet into the proper paths, your fathers and mothers, your teachers, and all the good men and women with whom you come in contact. Form the habit of observation, watch the conduct of those about you whom you can respect and love, and while you will soon find that there are some things about them which may not seem right to you, for we all are imperfect creatures at the best, you will also note many things which are well worth following.

REGULARITY OF HABITS IN ITS RELATION TO THE PHYSICAL LIFE.

If you have read carefully the chapters in this book which have preceded this one you will not fail to appreciate the importance of regularity of habits with reference to the care of your body. The illustration of the steam engine has several times been brought to your notice, and it will also be of service in this connection. Suppose a locomotive has to travel on a long journey every day, and not only do the work of carrying itself along, but it must pull a long train of cars with it. You may have noticed that it has rested in the round-house over night; that before it is taken out in the morning the one who has charge of it looks over all its parts to see if any of them are weak and unable to bear the strain which will be required of them. He sees that oil is supplied to all the bearings so that they will glide smoothly, and without friction, over each other. Then the fireman looks at the fire box and the boiler tubes to see that they are in good condition. If the water which is to be used in the boiler contains mud and stones he is particular, if he is the right kind of a fireman, to see that it is filtered and cleansed before letting it run into the boiler, for he knows it will injure it if this precaution is neglected. When he builds his fire he knows he must have coal which is as free as possible from slate and other impurities if he is to get the proper degree of heat to produce steam. Sometimes the engineer will also take a look over his machine before he starts the train to satisfy himself that all necessary precautions have been taken. Then when the conductor gives the signal, the train is started, with the assurance that, unforeseen accidents excepted, the engine will do its work, and carry cars and passengers to the end of the journey in safety and success. You know, and we all know that it was worth while to take all these precautions and all this trouble, and that because engineers and firemen have sometimes neglected them, accidents have happened which might have been prevented. If such precautions were taken before every journey accidents from breaking machinery would seldom occur. Now let us apply this to the human body, to your body and mine. In eating and drinking, if we do it with regularity, not at unusual hours, if we eat food which is of proper quality—not too much nor too little; if we drink only those fluids which will nourish us and not overstimulate or weaken us, we shall in all probability, have the proper fuel to get up the proper heat and do the proper amount of work. If we do the proper amount of work each day we shall give suitable exercise to the muscles, and help the blood and the internal machinery to do their work. This will give us a certain amount of fatigue so that we shall require rest; cessation from work is followed by a suitable number of hours for sleep; keeping this up, day after day, with occasional recreation and amusement, will in the majority of cases carry us along our journey with the same degree of safety that we predicted for the locomotive. How then, you will ask me, do you account for sickness and for break-downs? In the same way that we would in the locomotive, from unforseseen accidents and from unsuspected weaknesses. But what happens if these precautions are not taken, and regular habits of living are not formed in early life? Overeating, the eating of improper food at improper times, especially late at night, sooner or later causes rebellion in the digestive apparatus, and one becomes a victim of indigestion with all its pains and aches and all the misery which it leads to. It prevents you from doing your work properly, and if you try to force yourself to it, you will very often be compelled to abandon it from sheer weakness. Drinking habits formed in early life are usually associated with other habits which are bad. Their tendency is not only to prevent confidence in those who practise them, but to destroy the health as well. You have probably heard more or less about the sowing of wild oats when young, but you know that when a crop is sowed there will also be a harvest;

the harvest from such a sowing is not a desirable one. Let us not handicap ourselves by foolish and undesirable habits.

IMPORTANCE OF REGULAR HABITS OF SLEEP.

The importance of regular habits of sleep, especially during the growing period of life, can not be too strongly emphasized. There is nothing which will take the place of it. Young people may go without food, or be irregular in eating, and quickly recover from the effect of such irregularity, but to go without sleep for any considerable period of time, means a serious drain upon the vitality. Sometimes parents have a mistaken idea that they can accustom their children to require only a few hours of sleep each night. Unconsciously perhaps they are doing this when they allow the children to sit up until a late hour, habitually. This custom becomes more pernicious when children are taken frequently to places of amusement in the evening where they are subject to great excitement, and where their imagination is powerfully influenced. These are the children who are frequently victims of nervous disease as a consequence of such irregularities. They are often the victims of bad dreams and ''night terrors,'' and do not have half the chance for healthy growth which those children have who go to bed early without undue excitement, and with very little food in their digestive apparatus. Children are like plants in this respect; you can force them by unusual and unnatural methods, but they are not likely to develop into strong men and women any more than the plants are likely to become strong and hardy when they are forced in a hot house. An abundance of sleep for old and young, week in and week out, usually means that it will permit one to do his full share of work in the most satisfactory manner, according to the measure of his ability.

REGULARITY OF HABITS IN CONNECTION WITH THE IMPORTANT FUNCTIONS OF THE BODY.

One of the most important things which parents can inculcate in the minds of their children is the absolute necessity of attending promptly and regularly to the removal from the body of the contents of the bowels and bladder. There should be no false modesty about this matter. The substances which are in these reservoirs are poisons. They have been rejected by other portions of the body because the body could not use them, and it is not intended that they should be retained very long after they have reached these reservoirs. Parents are often very remiss in this respect, and serious and painful diseases are often the result of this folly and neglect. The habit of constipation which is annoying and injurious as well as so very common, can often be traced to early want of care and regularity for which the parents, especially the mothers, are responsible. One of the first requisites of health and of the ability to do the work of life properly, consists in the formation of regular habits in respect to these important functions. The skin, like the bowels and bladder, is also an organ by which waste and poisonous materials are removed from the body. You have been told about this before, that these materials are carried off through the perspiration. The offensive odor which comes from the skin of so many careless people, ought to teach you the necessity of keeping it clean. If you were to bury a living human being, leaving only the head above the ground, or if you were to cover the entire surface of the body with some kind of paint or varnish which would keep all the heat within the body, and would prevent the perspiration from getting out, the person would soon die, for the body would not be properly ventilated; and the lungs which work with the skin in getting rid of the body poisons, would have more than they could do. Therefore, regularity of habits is quite as essential in caring for the skin and its work, as it is for any other portion of the body. One should use reason and common sense in this as well as in all other matters. Some people bathe oftener than is necessary; many people do not bathe often enough. There are those who advise a daily cold bath for everybody, old and young, irrespective of their physical condition; others recommend a hot bath; there can be no specific rule; in some cases the hot bath is enervating; on the other hand, a cold bath may not always produce the desired cleanliness which is its chief object for those who possess good health. A brisk rubbing of the entire body with a coarse towel or brush will cleanse the skin and stimulate the circulation of the blood. This is in no wise an argument against the importance of the bath and the value of bathing; let the bath be used with an understanding of what it is expected to accomplish. If people consulted their physicians more frequently upon this subject they would use the bath more intelligently, and in many cases would thus be able to prevent or relieve diseases of the skin and other organs.

REGULAR HABITS ARE NOT INTENDED TO MAKE MACHINES OF PEOPLE.

These remarks in regard to the importance of regularity of habits are made for the purpose of appealing to your intelligence, boys and girls, old and young, and not to make machines of you. A twenty-four hour clock must be wound every day, or it will run down and stop going. There is only one way of treating it, and that is to wind it regularly. A living human being is not confined by such strict rules; but still the principle of regularity is valuable for him—regularity governed by intelligence. A boy would not become useless and helpless as a boy if he failed to get three meals a day at the precise time he was accustomed to eat, even if this happened several times;

nor would he necessarily get sick if he should lose some of his sleep for several night. Still the rule holds good that regularity in eating and sleeping is most important, and there is no doubt that much of the sickness and discomfort in human beings comes from the want of regularity in such matters. Sickness and the tendency to sickness, which amounts to about the same thing, are often overcome by giving up irregular habits, and following those which are regular; this is especially true with young people. A child whose parents have died of tuberculosis or some other terrible disease, often develops the same disease, but if he is placed under healthful conditions and good guidance he may not only avoid the disease, but grow to strong and vigorous manhood. ''An ounce of prevention is worth a pound of cure.''

PART IV.

THE ENEMIES OF THE HUMAN BODY.

CHAPTER XXVI.

Consideration of Enemies in General.

WHAT IS AN ENEMY?

AN enemy is a thing or a person whom you do not like, and which or whom you think is harmful or hurtful to you in some way or another. An enemy may be a thing or person which or who does not like you, to which or to whom you may appear to be harmful or hurtful. Thus one may be an enemy to you without being conscious of it, and you may be an enemy to another and not be conscious of it. It does not follow that the enemy of today will be an enemy tomorrow. Something may happen which clears up the enmity, and thus enemies may be changed to friends. Fortunately this is happening all the time in human experience; new light comes to us; we see that we were wrong in disliking or making an enemy of another; or the enemy changes his course of conduct and tries to do what both parties agree is right. If this were not so this world would be less pleasant as a place of residence than it is under present conditions. Men and women can be convinced if the proper means are used, that a cause of enmity may be seen from different points of view, and when the point of view is changed, the enmity frequently will disappear. Time also is a great healer of enmities and enemies, and if there is allowance enough of this excellent medium, most of the enmities of life will fade away. The Civil War in this country made the most bitter enmities and enemies, but among those living, who lived during that war, few are enemies to each other, no matter what their grievances or sufferings may have been while the war was in progress. Some there are who can overcome an enmity more easily than others; some find it most difficult to do this, no matter how hard they may try. This simply means that we are made with different dispositions, and that what is easy for one may be difficult for another.

ENEMIES WHICH ARE CONSTANT.

There are some enemies which will always remain enemies to us, and against which we must fight and struggle as long as we live. There is nothing which can cure or change this enmity. Disease and injury are enemies; they hurt us, give us pain and weakness, and are hateful from every point of view. If we say that there are exceptions, and that some diseases and injuries are beneficial, we simply mean that we are bearing a lesser evil that we may avoid a greater. Vaccination causes a certain amount of pain; if it *takes,* it causes fever and discomfort, and we bear them because we do not wish to catch the smallpox, an enemy which all of us prefer to avoid. The vaccination and the fever are merely the disagreeable preventive medicines which are taken in preference to the more disagreeable smallpox. Floods, earthquakes, avalanches, cyclones, volcanic eruptions, and other great disturbances of nature, are always and under all circumstances deadly enemies. We may take advantage of these calamities in some way or another after they have occurred, but we would always be better off if they did not take place, and gladly dispense with them. Many of the animals are our deadly enemies. Even an animal so apparently inoffensive as the common housefly is such an enemy, and we should try to exterminate him. He is the dirtiest kind of an animal; he breeds in filth and brings disease to the food which we eat; he carries disease germs from those who are sick to those who are well, and under the best of circumstances he is an annoyance which we ought to get rid of. So is it with mosquitoes, with rats and mice, and with vermin of various kinds. Many of the diseases to which men and animals and even plants are subject are caused by minute forms of vegetable life called germs or bacteria. They get into the body in various ways, they multiply in the blood, and are carried by the blood stream to various portions of the body and cause disease, and frequently produce death. All these enemies are constant enemies, and we will never be at peace until we have driven them away from us and out of the world.

ENEMIES WHICH ARE SUCH UNDER CERTAIN CONDITIONS.

Circumstances and conditions have much to do with our experiences, for what happens to us may in one case be regarded in the light of a friend, in another as an enemy. This is particularly the case with the forces and elements of nature. A thunder storm cools the atmosphere, moistens the earth, and makes the plants grow, but the lightning which comes with it may destroy a beautiful tree in front of our house, and kill some of the animals which were seeking shelter under it, consequently that storm is both our friend and our enemy. Fire warms our body and cooks our food, but it may also burn our house, and burn us to death too. The wind cools us agreeably on a hot day, and fills the sails of the boat which is carrying us over the water, but it may increase in fury to a hurricane, and blow down our buildings or sink our ship. The medicine which we take when we are suffering with pain soothes us, stops the pain and puts us to sleep, but if we take too large a dose of it we become stupid and unconscious, and may die. War is a terrible condition, nothing that we can imagine is worse; but wars have been fought which have brought freedom to slaves, put down tyranny and righted other cruel wrongs, so that wars have been both friends and enemies. Nevertheless, let us hope that it will never again be necessary to remedy wrongs in that way, and that men will abolish all such cruel business. The vigorous exercise which one man who is strong and robust, takes with great enjoyment is sufficient to kill his friend who has a damaged heart but does not know it. So we might multiply illustrations, for not a day passes in which the same thing is not friend and enemy to different individuals. The common saying which you have doubtless frequently heard, is a very true one "that which is one man's meat, is another man's poison."

ENEMIES ARE NOT LIMITED TO HUMAN BEINGS.

Enemies mean war, and war is always cruel, and yet war and enmity are seen throughout the entire course of nature. All the more reason is there, therefore, why man with his splendid development of mind and soul should steadily determine that he will conquer war. The plants have enemies in abundance; there isn't a crop that grows which is not attacked by some kind of bug, or germ, or disease, and everybody knows who has studied the matter at all, that only by constantly being on the lookout, and fighting these enemies can the farmer bring his crop to maturity. He must fight weeds, potato bugs, and any number of diseases which attack corn and oats and wheat; he must spray his fruit trees; he must dig out the incests which bore holes in his trees, etc. At this very time almost all the chestnut trees in certain parts of this country are dead or dying from a disease which has attacked them within the past few years. Many forms of vegetable life have disappeared from the earth because their enemies were too powerful for them. Do animals have enemies also? Yes, and in great numbers even more so than plants. Dogs and cats and rats and mice are almost always attacked by fleas which make them very uncomfortable. The fleas which are on diseased rats and mice often attack human beings and carry disease to them. The plague or pestilence which is now raging with such terrible effect in the Chinese Empire, destroying so many thousands of lives, is spread in this way. Certain diseases which affect hogs are transferred to human beings when they eat the pork which contains the germs of these diseases. Horses, cows, sheep, and many other animals have enemies in the form of germs and insects which attack and often destroy them. Even fish have their enemies; trout are sometimes in the early spring covered with lice or worms which must make them very uncomfortable. But animals also have enemies apart from these tiny ones which have been mentioned. Almost all fish live more or less upon other fish. The pickerel is a terrible enemy to small fish, and I have seen as many as five or six of the latter in the stomach of a pickerel The shark is an enemy not only to fish, but to human beings, and will kill and eat them whenever he has the chance. The wild animals are enemies to almost everything, and when they are very hungry they will even eat animals of their own species. Wolves are particularly savage in this respect. In fact, among all the flesh-eating animals, as distinguished from the herb-eating animals, there is this fierceness of disposition which delights in killing and eating other living things.

ENEMIES WHICH ARE BORN WITH US.

Does it not seem strange that we should have enemies as a part of our inheritance when we come into the world? Yet this is surely so, and is called our heredity which means something which has been handed on to us by our parents and grandparents. Such are the bad tempers, the inclination to steal, to tell lies, and to do other things which are wrong and which we possibly would not have if our ancestors had not been troubled in the same way. We inherit also such enemies as the tendency to disease which has been handed on to us. Some of these enemies can be overcome by the right kind of conduct and treatment as you will learn in the next chapter.

CONSTANT NEED OF FIGHTING OUR ENEMIES.

From the very moment therefore, when life begins, we must fight and struggle against our enemies. What would the animals do if they ceased to struggle in one way or another? They would surely be killed off, all of them. As it is, only the strongest, and swiftest, and smartest of them survive, and are able to have offspring, and thus continue their species upon the earth. What would become of the farmer or fruit grower if he did not constantly give battle to the enemies of his crops? Fortunately, if we know that we have enemies, and that they will destroy us unless we destroy them, the knowledge enables us to be on the lookout, and this idea of self-preservation is implanted in some form or another in all of us. It is very important that this idea should be firmly fixed in the minds of young people, for this will enable them, or should enable them early in life, to form habits which will tend to the preservation of health and life. Physicians realize this, and one of the most important subjects which they study and teach at the present time is that of preventive medicine. By studying the causes of disease we are often enabled to keep disease away from us, and this is far easier and more satisfactory than to try and cure a disease which has already attacked us. Not all diseases have been conquered as yet, nor have we discovered the causes of all of them, but patience and perseverance will win at last, and these deadly enemies will then be brought under control; at any rate under a greater degree of control than exists at present.

CHAPTER XXVII.

Enemies Which Come into the World With Us.

WHEN you see a young lady with beautiful hair and fine complexion, if you know her mother, you are very apt to say she inherits these attractions from her mother. If we see a boy with frank brown eyes and manly bearing, and are acquainted with his father, we are often impressed with the fact that he takes after his father in these particulars. On the other hand we are sometimes obliged to admit that a boy's bad temper, or a girl's disposition to say what is not true, is but the repetition of what we have observed in one or both of the parents. Such traits therefore, good and bad, are hereditary, that is, they are due to a law of life by which living things transmit or hand down their qualities and their peculiarities through successive generations. Children, therefore, in their main features, are like their parents. When parents are physically sound their children are usually physically sound also, when born, and this may be called good heredity. But when you who are reading these pages, have grown up, you will observe that a great many people have been born with more or less of a tendency to unhealthy conditions either of mind or of body. In fact, the majority of people come into the world with some kind of a handicap, and when we speak of the enemies which come into the world with us, we mean what has happened to us as the result of unfortunate or bad heredity. Just who is responsible for this unfortunate condition, is not always apparent in any individual case, but it is possible, by taking thought, to insure that you, my reader, shall not be blamed for the handicapping of some member of the next generation.

DR. OLIVER WENDELL HOLMES' OPINION ABOUT A GOOD CONSTITUTION.

Doctor Holmes was a very wise man, a doctor of medicine, and also a man who wrote many good things in prose and verse. Among the latter was a poem with which most school-boys are familiar, called "The Deacon's One Horse Shay." He said that if a man wanted to have a good constitution he should begin to prepare it with his ancestors three or four generations back, which simply means that he should have a good heredity, or as we sometimes say, he should be well-born.

A GOOD PHYSICAL CONSTITUTION IS A GOOD THING TO HAVE.

It is the best thing in the world to be well-born, not with a silver spoon in your mouth, but with a good mind in a healthy body. Many a child who is born to title and great wealth would gladly exchange his weak mind and puny body for the healthy strong body and mind of some poor fellow, especially such as are born and brought up on a farm. Since it is so essential in this life to be physically well born, and since everybody who is old enough to understand, realizes that good health is the most valuable of all earthly possessions, many wise men have spent much time in investigating these problems and riddles of heredity, and have found out that we can not expect to breed strong animals and plants unless we select strong subjects for parents in such breeding. Must it not be plain to you, in like manner, that healthy children should have strong and healthy parents? And the time to learn about these things is when we are young, so that we can successfully attack all these enemies which started in life with us. You must not forget, however, that it is not only physical traits that are handed down from father and mother to child, but moral and mental traits also. Indeed, strange as it may seem, a physical defect in a parent may appear as a moral defect in a child. So you can understand, as was pointed out in Chapter V, that Life and Health are very precious possessions and must be very carefully guarded.

WHAT IS MEANT BY THE PHRASE "BLOOD WILL TELL."

You have all heard this phrase, "blood will tell," and it is true in more senses than one. Good blood is a wonderful help in the making of clean and strong minds and bodies, and those children are very fortunate who have an heritage of good blood. You must not forget that the health of all our organs and tissues, depends on the quantity and quality of their blood supply, and their working is seriously affected by any impure blood which may be supplied to them. An illustration of the importance of good blood is seen in the case of people who are called *bleeders* who lack one of the important elements in their blood which causes it to thicken, or coagulate when drawn from the blood vessels. A slight injury to such people is sometimes sufficient to cause death from hæmorrhage, because it is impossible to stop the flowing of the blood. Parents whose blood is poor and watery may have children who are afflicted in a similar manner. Long life, or longevity, is an important consideration in connection with heredity. There are families in which some of the individuals live eighty, ninety, or even a hundred years, and this tendency is often handed down from generation to generation. This is, of course, a very desirable tendency to inherit, from many points of view. It is interesting to know that deformities of the body are not inherited. A man or a woman may be a hunchback, but they can not transmit that deformity to the children. Deformities may come to the children, of course, but they do not inherit this kind of misfortune from their parents. They may inherit defects of another kind however. For instance, if a parent were color-blind, and could not correctly tell one color from another, he might transmit this defect to his children. Fortunately, those who have defects like this can correct them by proper training and education. There are some diseases which seem to be handed down from one generation to another, or at least a tendency to them. The terrible disease which is known as cancer is one of these. A noteworthy illustration of this is the case of the emperor, Napoleon Bonaparte, in whose family cancer was said to have existed for several generations. The emperor himself died of cancer of the stomach, while a prisoner on the island of St. Helena. Obesity or fatness is a condition which seems to be common in some families, and when the individuals in such families reach a certain age they invariably become fat, no matter what they may do to prevent it. In other families baldness is almost certain to come at a particular period in life. Gout and rheumatism also seem to run in certain families no matter how carefully they may try to prevent them. Another peculiar fact in regard to heredity is that a disease which is common in one generation, may skip the next and even the second, and appear again in the third. Gout which may be present in the toes in one generation may appear in the next as asthma, or as a skin disease, or as a persistent headache, or as a joint disease, and these different forms of gout may affect as many children in a single family. There may be no well-marked disease at all as an inheritance, but some family pecularity such as a peculiar nose, or peculiar ears, or a particular color of hair and skin. Children of tall parents usually become tall, and small people usually have small children. A disease of the nervous system in a parent, is very often reproduced in the children. It may not be the precise form or variety which the parent had, but is one which distinctly marks disordered nerves; thus, one child may develop epilepsy or fits; another a tendency to alcoholic dissipation, and so on. The alcoholic tendency is one of the most unfortunate which can be inherited, but even this can often be fought down and overcome. Children with this tendency are badly developed, are undersized, have bad dispositions, and are often hysterical, or they suffer from bad dreams. They may be very bright and smart in school, and become brilliant men and women, or they may be very weak and cranky. Their moral nature is often weak and they may be tempted to do very wicked things.

WHAT HAS BEEN OBSERVED IN THE LIVES OF SOME OF THE GREAT MEN OF THE WORLD.

Let us now take a look at some of the pleasanter pictures of heredity, for we must not forget that splendid qualities of mind, heart, and body are transmitted, as well as those of the opposite kind. The power of application, the existence of noble ideas and beautiful thoughts seem to pass from one generation to the next. Books of biography tell us of families in which during several generations there are great scientists, physicians, poets, beautiful women, painters, musicians, lawyers, and other useful and distinguished people.

BAD TRAITS WHICH REPRODUCE THEMSELVES IN FAMILIES.

Tendencies to vice and crime are also very often transmitted from parent to child, to grandchild, or to great grandchild. A mental disease like insanity may reappear in a child in the form of an immoral or criminal tendency. In the Chretien family in France, John Chretien had three sons whom we will call A, B, and C. A had a son who committed robbery and murder. B had two sons both of whom were condemned for murder; one of these men had a son who was a robber. C had a son whose wife belonged to a family of house-burners, and of their seven children, one was a robber, the second was killed while attempting a robbery, the third was a robber, the fourth, a daughter, was a thief, and died in jail; the fifth, a daughter, died also in jail; the sixth was a thief; and the seventh, a daughter, had a son who was a robber and murderer.

TRANSMISSION OF INFECTIOUS DISEASES.

There are diseases which are caused by germs. There are two of them which I wish to emphasize because of their dreadful effect upon the human race. The first is known as tuberculosis, the second is syphilis. A parent having tuberculosis does not often transmit the germs to his children, but he does transmit a tendency to the disease. Children of such parents are scrofulous, that is, they have narrow chests, their shoulder blades stick out like wings, they are slow in teething and they have poor bones. They always have a catarrhal discharge of the nose and throat, and they are puny, weazened, and poorly developed. Notwithstanding these defects there is no enemy which is born with us which can be so successfully fought as tuberculosis. Consumptive parents often have perfectly healthy children, and if they can only be placed in healthful surroundings, and abundantly nourished, they often overcome the consumptive taint with which they began life. They will thus have conquered the enemy *tuberculosis* which was born with them, or which ever stood as a shadow to frighten them. But perhaps the most dreadful of all hereditary diseases is syphilis. Children with this disease often die in infancy; if they live they are likely to grow up with poor constitutions, to develop slowly in mind and body; their teeth are usually poor, they may be born deaf, and they often have eye disease. They may even be born blind and deformed. In some cases the symptoms of this disease do not appear until the victims of it have reached old age, and then instead of a peaceful old age, they may have pains and aches, and sores upon the body, and disturbances in the bones and be full of misery until death releases them. So you will believe that the statement was not exaggerated that this is a terrible disease, perhaps the worst and the most common with which mankind is afflicted.

ENVIRONMENT FOR THOSE WHO HAVE INHERITED DISEASE.

Environment means surroundings, and you will admit that when one has come into the world with disease it makes a great deal of difference whether his surroundings are bad or good. As there is bad heredity there may also be bad surroundings. It is often so in tenement houses with poverty, overcrowding, insufficient warmth, food, and shelter. If we would cure these diseases the first thing that is necessary is to improve the surroundings, help the sufferers to get better food, more sunlight, better air, and removal from the crowded apartment to the country. This is what is being done, slowly to be sure, by various societies and by city and State governments, especially for such diseases as tuberculosis. The result has been that many lives have been saved and lengthened, made useful and productive. Individuals with these inherited diseases must be taught to exercise their will—their will must be educated to urge them to get away from their bad surroundings, to determine to overcome their inherited weakness whatever it may be. Should not all these facts teach us the necessity of leading clean and useful lives? Should they not impress us with the fact that those who have such diseases have no right to bring children into the world with such an inheritance? If it be possible to cure the disease, let the disease first be cured, rather than to inflict upon others the tendency to all these ills.

CHAPTER XXVIII.

Enemies Which we Meet and Which Overtake Us on Our Journey Through Life.

INFANTS HAVE MANY ENEMIES.

DID you ever realize how large a proportion of the babies who are born, die before they have lived a year? In some countries as many as half of them; in some even more than that. Even in our country with all its advantages of riches and knowledge the death rate among babies is very high, higher in cities than in the country. Girl babies have a harder time than boys, and in some countries they are so unwelcome that their parents kill them. Think of having parents who are deadly enemies to helpless babies! Many babies are born with disease as you were told in the last chapter, and if they manage to struggle through infancy and childhood, are handicapped by their inherited disease all their lives. A baby requires very few things: air, food, sleep, and clothing, and these cost very little. Air and sleep cost nothing; food costs but a few cents a day; it costs nothing when the mother supplies it from her own breast; clothing may be very inexpensive; some babies wear none at all; some wear very little, and often it is given by friends and neighbors. A healthy baby therefore ought not to be a great burden on the pocket of its parents. But as a matter of fact comparatively few babies get these few necessary things, which they require in proper quantity and quality; in other words, they find enemies from the moment they begin to draw their breath; that is the reason so many of them die.

AIR.

We have told you something about the abundance of air. Babies who can live out of doors have little trouble from that source. But what about the thousands who live in tenement houses and cellars; in rooms that are too hot or too cold; in rooms that are crowded; in rooms which are filled with smoke, stale odors, and fumes of liquor; in rooms where there is disease. A baby must have pure air just as we must, and because they do not get it in some homes their resisting power is soon overcome, and they die.

SLEEP.

The extreme heat of summer weakens babies more than it does grown people; they become fretful and irritable, they can not sleep, and because sleep is more important to a baby than to a grown person they are soon worn out. A baby cannot sleep well in a room in which there is a poor supply of air, nor in a room that is noisy. In homes where there is plenty of air and plenty of everything else how often it is said to the children ''don't make a noise, the baby is asleep,'' but in the crowded homes of the poor there is seldom any consideration of this kind; the child has to get along as best he can, and very often he gets along badly.

CLOTHING.

The baby's clothing is often of such a character that it is harmful to him. It is wonderful how little intelligence thousands of mothers show in this particular. If the clothes are tight they interfere with his motion and his breathing; if they are too light, or too heavy, they also cause him discomfort. The only thing he can do is to fret and cry, and then the mother wonders why the baby is so cross. If the custom of the country requires it, the baby is tied in his clothes, like a mummy, and can not move hand nor foot. Indians, Eskimos, most of the nations of southern Europe, etc., have this barbarous and senseless habit.

FOOD.

But the greatest enemy which the baby has, is connected with his food supply. He has the best chance to thrive and grow when he is fed, as nature intended him to be fed, from his mother's breast. A mother who can nurse her baby and will not, is an enemy to her child, and too often she realizes this fact only when it is to late to remedy it. To bring up a baby artificially is frequently one of the most difficult problems which a mother has to solve. Even when she has the constant advice of a skillful physician the problem may be too difficult for successful solution. If she is unable to have such assistance, and either has no doctor, or only such help as she can get at a public dispensary, the result is often a very bad one for the poor baby. The greatest enemy in connection with infant feeding is want of cleanliness in preparing its food. It takes a great deal of time to keep nursing bottles clean, to heat the food, and to see that the latter is always sweet, and free from injurious substances. When you think of the thousand things that a mother must do about the house, with other children to look after—is it a wonder that she sometimes fails to be as particular about the baby and his food as she ought to be? Mothers, especially ignorant mothers, are often careless about the quality of the milk which is provided for their infants. It frequently is not as fresh as it ought to be, and to put milk which has begun to sour into a baby's sensitive stomach is about the surest way to cause disease of the stomach and intestines. You would be astonished to see what is sometimes given to a baby in addition to milk; ham, potatoes, macaroni, and many other food substances which it is absolutely impossible for him to digest.

I have been told by parents, and with apparent pride, that the baby could eat anything which was on the table for the rest of the family. Enemies to the baby are often found in the various prepared foods which are so extensively advertised. They are frequently given on the recommendation of somebody who had found that one or another of them agreed with her baby, without any knowledge of the baby's requirements or of the nature of the substance which was being used. Food which is least likely to make a baby sick, if he must have artificial food, is clean, sweet, fresh cow's milk, and if it has been pasteurized, that is brought to a temperature of 140 degrees F. for five minutes, it will be less likely to cause digestive disturbances than if used without such heating. It may not be quite as nutritious as that which has not been so prepared, and some doctors object to it on that account, but for the busy mother with many cares, who wishes to have the safest possible food for her baby, and at the least expense, it will be a welcome friend. Of course, it must not be given undiluted to very young babies; water which has been boiled and strained being added to it from a quarter to a half as much water as milk, according to the richness of the milk and the physical condition of the baby. A little salt or baking soda may be added, and it will often be well to sweeten it with a sufficient quantity of milk sugar which should always be fresh. If the milk is not very rich, its nutritive value will be increased, and digestion will be favored by adding a few teaspoonfuls of cream to each feeding. If the food is vomited and is sour, or if there are curds in the baby's stools it usually means that the milk was not sufficiently fresh, or that not enough water had been added, or that the proportion of cream should be larger. Thousands of babies die during the first months of life because of the want of proper food, and it must certainly be apparent to any mother who reads these lines that it will be wise for her to consult an intelligent doctor the moment the food disagrees with the baby.

WANT OF CLEANLINESS.

The injury to babies from want of cleanliness is greater than is usually supposed. If babies could live out of doors like animals, and without clothing, they would probably suffer from this cause as little as do the animals. But in civilized countries, and away from the tropics, infants do not live out of doors nor can they usually dispense with clothing. The daily bath for infants is desirable, but not indispensable. Harm is often done to the delicate skin of infants by too frequent and too harsh scrubbing in connection with the bath, but it is not usually safe to allow many days to pass without the full bath. ''One of the most woe-begone and filthy infants I ever saw,'' said a well-known physician, ''was brought by its mother, a poor working woman, to a dispensary for children in Vienna. When the doctor asked her if she ever washed the baby she replied 'yes, on Friday, which is my wash-day.' '' The injury to infants from insufficient bathing is caused by harmful substances which become attached to the clothes, and from them are communicated to the sensitive skin. Particularly does this injury come from soiling by the discharges from the bowels and bladder. It may also come from the discharges from sores upon the baby's body and this is not unusual when the baby comes into the world with such a loathsome disease as syphilis. Want of cleanliness is so important in some of the eye diseases of infants that it often results in blindness.

THE ENEMIES OF CHILDHOOD DIFFER FROM THOSE OF INFANCY.

We have seen that the common enemies of infancy were chiefly bad air, insufficient sleep, improper clothing, and bad food; especially the last. When children have obtained their teeth, and their digestive organs have grown both in size and in their ability to dispose of food, they naturally will have greater resisting power than infants whose digestive organs are intended to receive nothing but milk, especially milk which is not too rich in cheese.

OVER-EATING.

The food problem with growing children is therefore chiefly to satisfy their ravenous appetite without stuffing them. Of course, there are many children who never know when they have had enough of food which they like, and will stuff themselves as long as the supply holds out, or until their stomachs will not contain any more. At certain times they also have an uncontrollable desire to eat improper things, as occurs, for example, during the green apple period. Overeating and eating improper food are therefore enemies of childhood from which they frequently suffer, especially in their stomachs and bowels, and for which the help of the doctor is often required. But nature is usually very kind to them in such emergencies, especially if they are fairly well-developed children, and a glass of lukewarm water with a little mustard in it will empty the stomach of its offending contents, or a good dose of castor oil will relieve their intestines, and they will usually be as well as ever in a day or two, and ready, possibly, to try the experiment over again, for children do not always learn as much from experience as grown people.

EXPOSURE.

Growing children frequently suffer from exposure by which is meant getting their shoes or their clothing wet, or getting the body chilled with cold, or getting tired out with play or with exercise. Who has not seen children playing in puddles of water, or wading in the gutters after a heavy rain with the utmost indifference to wet feet, and with consideration only for the enjoyment of the moment? Who has not seen them paddling about in the rain, wet to the skin, but smiling and happy? Of course there are many cases among the poor where such exposure can not be helped, and where shoes and clothing are all too insufficient for protection. The same remarks apply as to exposure to cold, some children running out and exposing themselves in any weather, and then coming into the house, benumbed and chilled, perhaps crying with pain, and others, alas, chilled because they do not own sufficient clothing, and because their parents can not or will not get it for them. Children are very much like little animals in many ways. Like animals they do not enjoy being shut up in the house. Like them they enjoy rolling in the dirt, and being out in all kinds of weather and, of course, sickness sometimes follows as a result. But perhaps this is not so in the majority of cases, and it is better for a child to take a few risks than always to remain in the house. Depend upon it, there is usually something wrong with a child who habitually prefers to remain indoors, for this is not the natural tendency with healthy children.

LATE HOURS.

It has frequently been stated in the foregoing chapters that children should go to bed early. It is distressing to one who knows the bad results which are almost sure to follow, to see children sitting up, and with their parents' approval, when they should be in bed; to see them in places of public entertainment excited and over-stimulated, and to realize what a heavy penalty must be paid for this indulgence, especially in the form of nervous disease which is common among sensitive and excitable children.

BAD COMPANIONS.

Children suffer from evil associations even more than grown people, because, like the moist clay, they take impressions so easily. A child who lies or cheats or swears, or uses other bad language, often corrupts an entire neighborhood of children. Parents ought to know a great deal about the playmates of their children, and whether they are putting bad notions into their heads or not.

BAD HOMES.

Unfortunately, since children can not select their homes, they must be provided for them. I have seen many a home which has been the controlling influence in causing a child to grow up to bad manhood or womanhood. If a child grows up in an atmosphere of vice and crime, if it is familiar with drunkenness, blasphemy, and vulgarity from the dawn of its consciousness, what can be more logical, as a result, than that it should continue in the way in which it was brought up? Those who have investigated this subject have occasionally found families in which every member, generation after generation, has been a criminal. A family of this kind is mentioned in the chapter which precedes this one. There is also another notorious family of criminals by the names of Jukes, which, beginning with a woman who was immoral, numbered in a few generations more than one hundred and thirty, all of whom were criminals or vicious in some way. The home also becomes an enemy when it is damp and dark and unhealthy, as thousands of homes are, especially those which are in the poorer kinds of tenement houses, and when there is disease in them which little children are very apt to catch. It is a bad home when it is so hot and ill ventilated in summer that the children must go to the roof or the street in order to get air enough to breathe, or when it is so cold in winter that they can not keep warm, or when there is so little food there that the children can never remember when they had enough to satisfy their hunger. All these incidents in the home life leave their mark on children and often decide what their future is to be.

ENEMIES IN THE SCHOOL.

These surely ought to be the children's friends, but too often they are not. In too many instances, especially in cities, the schools are overcrowded and badly ventilated, the light is bad and the children are compelled to study with the light shining directly in front of them instead of coming from behind or at the side. Frequently children do not realize that they have such a cause for complaint, but the headaches and eye-strains and some of the other ills from which school-children complain, when carefully investigated, often point to the bad and unsanitary arrangements of the school which they have been attending. It would seem strange, too, that the teacher could be considered an enemy, but this is by no means uncommon. A teacher may be half sick, or he may have a temper which is not under good control, or he may be naturally brutal and coarse, or weak and a poor disciplinarian. Like many other people, he may have strong likes and dislikes; he may favor children whom he likes, and slight those whom he dislikes. If also the teacher is lacking in patience, in intelligence, in love for his work, how can he expect to have power for good over his children? He will not. The school is often an enemy, because it is there that disease is frequently communicated, not so frequently as formerly because, in many places, there are physicians who are inspectors of schools and school children, and they are doing much to remove the risks from infectious and other diseases which were very common a few years ago.

OVERWORK AS AN ENEMY.

Yes, this is still an enemy to little children. There is many a home where they are called upon to do more than they are physically able to do. Sometimes when the mother is removed by death there is only a little girl to look after the household; many a household has such a little mother. Or if the father is taken, how often we hear of little boys being put to some kind of hard work, and compelled to supply a portion of the meager income of the family. How many bootblacks and newsboys are there who look as if they had just graduated from the nursery! But these are not the worst cases of overwork in children; worse than these are the ones in which little children must work in mills and factories and mines and shops, long hours by day or by night. This is one of the great crimes of civilization that little children should be thus abused. Greed and selfishness are usually at the bottom of it; often it is the greed of the parents whose love for their children seems to be measured by the amount which they can squeeze out of them. But much improvement has been made, and more is coming. The children belong, in a certain sense, to the state, and even the parents have no right to so abuse them that it will affect their future usefulness as citizens. Still less have their employers the right, morally or otherwise, to work them, amid unsanitary or unsafe surroundings, more hours and at harder work than their physical condition is intended for. Of course it means, in a great many cases, the ruin of the child's body, and an early death.

ENEMIES FROM SICKNESS AND INJURY.

Children have plenty of enemies of these kinds, some of which can be avoided and prevented, while others can not. The infectious diseases diphtheria, measles, whooping-cough, scarlet fever, mumps, chicken-pox, etc., are common enemies which few children escape. The great thing is to have the children in a good phyical condition when they contract a disease, to give them such rational and sensible treatment when they have it that it may run as mild a course as possible, and be as free as possible from complications. Of coure, even with the best of care, the result will sometimes be disastrous. Children are often the victims of injuries and accidents, falling and bruising themselves, sometimes even breaking bones, running slivers into their fingers, cutting themselves, and getting hurt in a thousand ways which grown people can avoid, because of their greater knowledge and carefulness. Fortunately the great majority of the injuries of childhood are of such a character as to be quickly recovered from; kindly nature is generally on the side of the child. The more serious injuries are usually such as can not be avoided or foreseen, and all we can do is to manage them as wisely as possible when they occur.

DO CHILDREN WHO ARE APPROACHING ADULT LIFE HAVE ENEMIES WHICH DIFFER FROM THE ENEMIES OF THOSE WHO ARE YOUNGER?

Yes, distinctly so, because the child who is from ten to fifteen years of age is a different being from one who has not reached that age. As a child approaches maturity he is better able to meet the enemies of that period than a younger child. His muscles and bones are stronger, the organs, or machinery within his body, are able to dispose of more food and more kinds of food than is possible in earlier life. The diseases which attack so many children under ten years of age are not so frequent after that age, and children have then had enough experience to know that there are certain things which they can not do without suffering pain and discomfort. You would scarcely expect a child who was older than ten to try and take hold of the flame of a lamp, however pretty it might seem to him. Children of this period are often overworked just as younger children are, but if they have survived the enemies of earlier life they can meet demands for overwork, long hours, and heavy toil with some probability of holding out until they reach maturity. At the same time they are none the less in need of protection, and are gaining friends in all countries; governments are steadily influencing legislatures to pass humane laws in their behalf.

TEMPTATIONS TO IMMORALITY AND VICE ARE ENEMIES OF THIS PERIOD OF LIFE.

The enemies which are most to be feared as youth approaches manhood and womanhood are the temptations to immorality and vice. The passions and appetites are strong, the world is very alluring, and many coarse pleasures, which would have no charm for those who are mature, seem very delightful and attractive to youth. Many young people seem to think it is very smart to be bad, and to boast of the bad things which they have done, as if this could possibly add to their reputation among those whose good opinion is desirable. Young people are often painfully deficient in the sense of proportion; conceit and vanity are exceedingly common among them; and they often do reckless and foolish things from love of applause, or because they hope to win applause. The self-confidence which comes at this period is too often an enemy. It is the direct consequence of the deficient sense of proportion above mentioned. While it is a most admirable quality if properly directed, it leads to all kinds of mistakes and pitfalls when misdirected. It is this which often leads young people to go beyond all proper limits of endurance in athletic games, to take risks which are almost certain to result in permanent injury, and to make exertions and strains which, not infrequently, are followed by fatal results. The newspaper accounts of fatalities and casualties in connection with rowing, running, baseball, football, and other intense games does not begin to cover the actual number of such accidents and mishaps.

CHAPTER XXIX.

The Story of Bacteria and Bacteriology.

THE word bacterium (plural bacteria) is derived from the Greek and means literally a rod or a stick. We use the word nowadays to signify the most minute plants. Bacteria belong, therefore, to the vegetable kingdom, but as we shall see later on, they are not all rod-shaped. Bacteriology is the science which teaches us the mode of life of these minute plants, their characteristics, their growth, their habits, the part they play in our lives, both in health and disease, and how they affect not only our well-being, but also that of other plants and animals. You have just read that bacteria are very small, but it may interest you to know that some of them are so minute that a million could pass through the eye of a sewing needle if they were placed side by side. You see, then, that it is impossible to observe them with the naked eye; powerful magnifying glasses, known as compound microscopes, are necessary to bring them into view; but even though we can today enlarge them millions of times, they are still too small to permit of a close study of their structure, which must be quite complicated, as you will see presently when we discuss some of their products. The shape of these germs, as they are often called, is often that of a rod, or they may be quite round, or oval. Some forms occur only singly, others grow in pairs, and still others form clusters and chains and cubes. They are usually transparent, but many of them form vivid colors, such as violet, yellow, green, blue, and red. Now it may be a surprise to you to hear that many forms of bacteria can move about in fluids in which they may occur, and that their motions in liquids are often quite rapid, especially when the temperature is high. With few exceptions they require warmth, just as other plants do, and they also require moisture. But unlike other vegetable organisms they do not thrive well in the presence of light; sunlight is the greatest enemy of most of them. You may wonder how they move about, and ask why they do not belong to the animal kingdom. At the ends or the sides of the body there are often very fine hairs which act like so many feet, so that when you see some of them very much enlarged your little plant resembles a centipede; but they are not animals, because the structure of most of them and their life history shows them to be plants. Nevertheless they have many things in common with the most minute animals, and you are right in thinking that they occupy the borderland between the two great kingdoms of living beings: the animals and the plants.

LOUIS PASTEUR, THE FATHER OF BACTERIOLOGY.

People have known of the existence of bacteria since the latter part of the seventeenth century, and it was a Dutch lens-maker who first described them. It was believed they created themselves out of nothing, an error which was not corrected for many years, and they were believed to be animals. The science of bacteriology did not exist in those days, and it remained for a French scientist, Louis Pasteur, to create it, and he is known therefor in the civilized world as the "Father of Bacteriology." As his work is of such great importance, I propose to tell you a little about this great man. Louis Pasteur (pronounce, Pas′têr′) was born in 1822 and he died in 1895. His works are too numerous to be mentioned in this article, but what we want to remember is that it was he who first showed that the fermenting and souring of fluids was caused by bacteria. He showed that decomposition and putrefaction were due to their presence. It was Pasteur who recognized bacteria as disease producers, and he attempted to find ways of protecting both human beings and animals against them. In these efforts he succeeded to some extent. He grew bacteria just as we grow plants in pots, and he succeeded in modifying the poisonous properties of many he cultivated. He vaccinated people who were suffering from certain diseases with germs of the same variety found in the disease, and so succeeded in curing many people. He could likewise protect healthy beings against certain diseases by vaccinating with modified bacteria grown by him. He was first to produce immunity. We shall hear later on more about this form of protection called immunity.

You have heard that people bitten by a rabid dog have to take the ''Pasteur treatment.'' This same Louis Pasteur found the means of protecting us against the most terrible disease, known as hydrophobia, or rabies, which is caused by the entrance of minute forms of life belonging to the animal kingdom into the body.

HOW DO BACTERIA DO HARM?

In the first place, we will remember that bacteria are not always harmful; indeed, many forms are both necessary and useful in the economy of nature, as we shall see later on. But there are many which cause disease, and they do so when certain conditions in the human body permit them to do so. Our body in a perfect state of health is proof against bacteria, but even a small scratch may give them an opportunity to grow and cause disease; the injury may be ever so slight, and it may be upon the outside or the inside of the body. As we do not live the primitive life of our forefathers, we have become more susceptible to infection with bacteria. The higher the degree of civilization the greater the risk of infection, because this same civilization has brought with it changes in habits, food, and dress not calculated to shield us from injury. Bacteria being present everywhere, not only in nature but in our body, we would have but little chance to survive their attacks if it were not for what we know as the "resistance" of the body. Now there are, roughly speaking, two kinds of bacteria, those that live on dead particles and those that live on living structures. In health, all of those living in the body are existing on useless and dead particles and on food we have partaken of; they do no harm, as they have not gained entrance into the tissues of the body. Now, all living things have to eat or absorb something in order to grow, and they have likewise to rid themselves of the useless residue which remains after the abstraction of the useful parts. It is this residue which causes disease when bacteria enter the tissues of the body, and we call it a "toxin." A toxin, then, is a poisonous substance formed by bacteria. Again, bacteria may gain entrance and grow in such enormous numbers that they block vital channels in the blood-stream of the body. A few form gases, and thus do harm.

After having once invaded the tissues of the body, the bacteria feed on its juices and cells. These cells are the minute particles, microscopically small, of which every living being is composed. The hair, the nails, the skin, the bones, the brain, the blood, and the internal organs, all are composed of cells. Each kind of cell has its work to do, and that work is not under our control. They are the workers, but they are also the soldiers which protect the body as a whole. Many forms of cells are absolutely necessary for life as a whole, and if bacteria can poison them, either by feeding upon them or by their toxin, then we have disease. To give you an illustration of how powerful and swift their poison may be, let us consider a few of them.

THE BACTERIA OF LOCKJAW.

In the earth, in dirt, we find a germ known as the germ of lockjaw, or the bacillus of tetanus. This minute bacterium may be present on our skin when our hands are soiled by garden earth, and under many other circumstances. It does no harm then, but if it should gain access through a badly torn wound, it would grow. As long as the oxygen of the air reaches it, it can not grow, but once this oxygen is excluded, it multiplies. This germ of lockjaw does not enter any other body parts than just those originally invaded. In time it produces a toxin so powerful that the infinitesimal part of a grain will kill a mouse. This poison acts in such a manner that it causes certain muscles to stiffen, and the person so afflicted can not move them; as those muscles we use for the act of swallowing are stiffened and rendered useless, the patient can not eat, and finally dies unless a way is found to counteract the dreadful poison. Later on we shall see how this may be done, for instance, in diphtheria.

Other forms of bacteria, having once broken through the skin, will cause the underlying structures to putrefy, and an abscess results. Others again, like the germ of consumption, known as the tubercle bacillus, invade, for instance, the lung and destroy it. The germ which causes diphtheria is one which may give rise to a peculiar inflammation of the throat, a peculiar skin forming which may choke the sufferer, and of course, all these bacteria form powerful toxins which affect in varying degree the internal organs, and consequently the general health. Even these disease-producing germs are often with us in health; they may be in our mouths, and it behooves us to be careful in eating and of our habits in general to prevent them from gaining the upper hand.

EXPERIMENTS WITH BACTERIA.

You might ask, how do you know that bacteria cause disease, especially when you state that they may be present in health. Before any germ is believed to be a disease producer, it must be proven by experiment that it is capable of reproducing the disease when grown outside of the human body. How is this done? Before we can understand such proof we have to consider means of growing bacteria outside of the body. If we take some beef extract and add a little salt and make a soup by placing it in boiling water, we have a nutritious liquid in which bacteria can thrive. To make certain that all those contained in the beef tea and water have been killed before we start our experiment, we heat this soup to the boiling point on three successive days. This is necessary, as certain forms of bacteria can actually resist (for some time) the action of boiling water. After the third heating we have a sterile fluid, that is, one in which no living germs are left, and which may be kept germ free forever. If we touch this clear liquid with our fingers, or expose it to the air, we see it become cloudy after a day or two, and if we now place a minute drop under the microscope we see that the cloudiness is due to millions of bacteria.

The sterile soup I have just told you about is kept in long thin glass tubes, called culture tubes, and stoppered with a bit of cotton. If we remove the cotton, air can enter the tube and the liquid will become cloudy after a day or two. Supposing now we have an infected finger, or a sore, and we transfer a little of the matter or pus from this infection to a little sterile bouillon by means of a platinum wire, which has been heated in a flame so as to be sterile (that is, free from bacteria) before we touch the sore with it; we shall see this soup become cloudy in a day or less if we place it in an incubator. (An incubator for a germ is a small oven which is kept at the temperature of the blood by means of a small gas flame.) Now, we want to prove that the germs in this soup really caused the sore. We must make them produce a sore, and to do this an animal is used. We will take a rat and inject a small amount of the infected soup under its skin. Within a day or two we may see the development of a sore where we injected the fluid, and if we now examine some of the matter from it under the microscope we may see the same kind of germs as were originally found in the infected sore on the finger. You may say that the injection of the soup alone under the skin of a rat may have caused the sore in the rat, but if we inject some sterile soup into another rat, we find that it does no harm. In this way the poisonous properties of germs have been tested.

HEAT, LIGHT, AND AIR ARE ENEMIES OF BACTERIA.

Different kinds of germs require different degrees of heat for active growth, but most of them grow at the temperature of the body in the presence of moisture, and they may multiply so fast that from a single germ many millions are formed in a single day, as some reproduce their kind every twenty minutes, or even less.

You may wonder why bacteria multiplying so rapidly and being present everywhere do not occur in greater numbers from day to day. It is fortunate for us that most of them do not readily find suitable food and surroundings, and sunlight kills many of them. Then we constantly destroy millions of them daily, either by means of chemical substances or by cooking. When we boil milk or water, and when we cook meat and vegetables, nearly all bacteria are destroyed; the reason for this is that *moist* heat is the greatest enemy of bacteria, and only a few harmless ones survive cooking. Then we use daily many forms of disinfectants, all of which kill many bacteria. In hospitals and wherever operations are performed, the greatest precautions are taken so that everything used and handled during these operations be absolutely sterile, that is, free from bacteria. In spite of the greatest precautions, bacteria may become a source of danger, as it is not possible to sterilize the air in which such work is done, and a puff of wind, laden with bacteria, may carry harmful forms of them into an operating room and cause an infection.

The number of bacteria about us depends, to a great extent, upon our surroundings. What we need most is light, not artificial light, but life-giving sunlight; then we need ventilation, and above all cleanliness. Then we will have fewer bacteria, and hence the risk we run is diminished.

HOW WE RESIST BACTERIA.

How do bacteria reproduce themselves? The majority just divide into two pieces, each of which grows and divides again into fragments. Some others form spores, that is, they form a sort of kernel, which is much hardier than the parent plant, much like a seed of a plant which can be dried and planted after a year or more.

One of the wonderful discoveries of recent times is the fact that we can render the human body proof against certain dangerous forms of germs. This is called immunization. We have a certain amount of natural immunity, that is, there is in us a force which prevents bacteria from doing us harm. But we can so fortify the body that the entrance of millions of dangerous forms of bacteria will not produce disease, and this is done by the injection of small amounts of cultures of the germ against which the body is to be protected. This was first done by Louis Pasteur.

The methods used by him have been changed, but the principle remains the same. Instead of injecting living bacteria in small numbers, as he did, we kill the bacteria first by heating them for a certain length of time after having grown many millions of them. If they had been grown in soup, as described above, we should find in this soup a poison, a toxin, generated by the growing bacteria.

To avoid this toxin, there is added to the bouillon while it is hot an eastern sea-weed, called Agar-Agar, which swells up and makes a firm, smooth mass out of the soup when it has cooled. This mixture is drawn off while hot, and fluid, is put into narrow glass tubes and carefully stoppered and sterilized. Into these tubes, commonly called agar-tubes, we place the germs, and their toxins soak into the agar mixture, while the bacteria remain on top and can be scraped off. They may now be transferred to sterile water, to which some salt has been added, and shaken up so as to distribute them evenly throughout the fluid. Now their number is determined under the microscope. Dead germs so prepared are called "vaccine." You may have read that the governments of civilized countries vaccinate their soldiers against typhoid; this is done by the injection of dead typhoid germs under the skin. The result is immunity against typhoid, which means that the person so treated can not contract typhoid fever while the protection afforded by the vaccine lasts. If the vaccine given was a typhoid vaccine it will protect only against typhoid fever. Scientists the world over are working along these highly important lines, and in years to come means may be found of curing and protecting against many diseases due to bacteria.

There is, for instance, that dreadful scourge, the plague. Even today the disease flourishes almost unchecked in some parts of Asia, even killing those who study means for its extermination. The germ causing it is known as the bacillus pestis, and protective fluids have been formed, but they are imperfect. You must remember that all such epidemics are much influenced by sanitary conditions. We see this beautifully illustrated when we compare the Panama Canal Zone and the island of Cuba of today with what they were but a few years ago, when yellow fever carried off thousands of people. Diligent workers in medicine found the germ of yellow fever to be a bacillus, and they found, furthermore, that this germ was carried and inoculated into human beings by a certain kind of mosquito. It was reasoned that by improving sanitary conditions, that is, drainage and cleanliness in general, the mosquitoes could not flourish, and in this manner the danger of infection by yellow fever carrying mosquitoes would be greatly reduced, and such proved to be the case.

Diseases like cholera are caused by a curiously-shaped curved bacillus, called a spirillum, or the comma bacillus. This germ swarms in enormous numbers in the excrements of the sufferer from Asiatic cholera, and as it can live in the river water into which the bodies of the dead were frequently thrown, it was carried from place to place. Flies also carry it, and possibly rats. It is for this reason that such strict quarantine is maintained on incoming vessels that have touched at ports where plague, yellow fever and cholera were doing their deadly work. Insects and rats are much to be dreaded as disease carriers in general. Malaria, which is not a bacterial disease, being caused by a minute animal parasite, is carried and developed solely in the body of a certain species of mosquito.

The most efficient anti-toxin made today is the diphtheria anti-toxin, and is obtained in the following manner: A certain number, millions, of diphtheria germs are injected into a sound horse. The horses so used in the service of mankind are especially cared for under most sanitary conditions. The number injected, that is, the so-called dosage of germs, is not great enough to kill the animal; it will sicken to some degree, but quickly recover, and then a second injection is given of double strength. When the effect of this has worn off, four times and then eight times the amount will be injected, and the horse will now be immune to diphtheria. What happened is this: The body cells of the horse developed substances which circulated in the blood-stream and which became gradually so strong that the horse was protected against the diphtheria germ. If some blood is now drawn from the horse and allowed to stand, a clot will form and the rest will be a yellowish liquid called the serum, and this serum will be found to contain the protective substances. This fluid is now the diphtheria anti-toxin, and we can prove its protective powers by injecting two guinea pigs with living diphtheria bacilli and give one of the guinea pigs at the same time an injection of the anti-toxin. The guinea pig protected by the anti-toxin will not even become sick, while the unprotected one will die. When the protective strength of the anti-toxin has been determined, we use it to protect human beings against death from diphtheria by injecting a certain amount into those who suffer from the disease. This anti-toxin production is one of the instances where animals are used in the service of man, and we are fortunate in being able to produce so useful a substance with very little suffering of the animals so used.

FRIENDLY BACTERIA.

We have stated above that bacteria are present everywhere in nature; they are present in the food we eat, and you may ask why they do no harm. Most of them are killed as soon as they enter the stomach. In health we find in the stomach a mineral acid of such strength that but few can escape. Nevertheless, the interior of our intestines swarms with these minute beings, and instead of their being a hindrance, they have actually become a help to us, as they materially assist in breaking down the food we partake of into its ultimate component parts, which eventually are taken up by the body and used in replacing the waste which is the result of our activity.

In nature we see the same beneficial effect from bacteria. There are the dead leaves and plants and the dead bodies of animals which have to be broken up so that their elements may be used over and over again in the economy of nature; if it were not for this conservation of elements we should soon cease to exist, for the very substances we live on can not take their food particles out of the soil unless it be in a very elemental state, and we have to thank bacteria for making this possible. This fact was recognized long ago, and certain forms of bacteria are now employed to enrich the soil so as to render it nutritious and palatable to the plants, upon which we and the animals subsist.

BACTERIA IN YEAST.

Many of the foodstuffs we partake of and have come to regard as necessities are made by fermentative processes, and this fermentation is due to certain forms of bacteria. The yeast we use in making our bread is a bacterium. The formation of vinegar, the ripening of cheese and the souring of milk and rancidity of butter are all due to bacterial action. If, therefore, all bacterial action were suspended, we should starve and die, as no more plants and trees and fruits could grow, and our digestion would be incomplete.

With every breath of air we inhale bacteria, but fortunately they do not reach the lungs; the moisture and mucus of the mouth and throat catches them. Experiments have shown that they are carried for long distances by wind currents, and in the country the number of bacteria in the air will be greatest if the wind blows from the direction of a city. The seasons have naturally much influence upon the numbers of these air bacteria; there are fewer in winter than in summer, but the greatest number appears to be present in the fall of the year when the leaves drop and decay.

There is so much that remains to be learned about bacteria that today our knowledge is admitted to be very imperfect. Everybody should know something about them, and understand that by obeying the demands of our Health Boards we protect ourselves and those who follow us, and lessen in this wise at least such diseases as are known to be of bacterial origin. This holds true especially of tuberculosis, the ''white plague,'' as it is called, and we should all see that the rules against spitting are enforced.

Sneezing is equally dangerous, as in the air and moisture so expelled we sow bacteria broadcast.

As milk is a great carrier of disease germs, we should be be careful to see that it is pure.

Flies are probably greater germ carriers than anything else, and as they can only breed where unclean conditions exist, we must try and prevent them from multiplying by absolute cleanliness, and use screens to prevent them from contaminating our food.

PART V.

Useful and Important Facts for Parents, Teachers, and Young People.

CHAPTER XXX.

Some of the Common Diseases of Infancy.

IT is proper to distinguish the diseases of infancy from those that occur later in life. The line of distinction between the diseases occurring in early and in late childhood is not so marked, although children that have passed the tenth year are usually better equipped physically to resist the influence of disease than those that are younger. Children under ten are very likely to have the various infectious and contagious diseases of childhood. If they escape them until that age, it is quite possible that they may escape them altogether.

Infants are not subject to a great variety of diseases. It is true that mortality in the first year of life is very high; this, however, is not due to a multitude of diseases, but chiefly to the enemies mentioned in the previous section of this book.

When we think of the customs of the past, even among intelligent nations, of the number of babies that were killed by their parents because they were not wanted, or because they were females, or because they were feeble or deformed, or because a bloody religion demanded them in sacrifice—when we think of these things, and compare them with the efforts to save infant life wherever civilization and Christianity have penetrated, it will be readily admitted that great progress has been made, and that the average baby has a better chance for life today than he ever had before. Recall, in proof of this statement, the many hospitals for the babies of the poor, for deformed and diseased babies, for foundlings, and the constant efforts to educate and help poor and ignorant mothers in the care and nourishment of their children.

DISEASES OF THE EYE.

Until within a few years, diseases of the eye were very common in new-born infants, very difficult to treat, and almost always resulted in blindness. They were usually contracted by the infant from its mother on its way into the world. Because this disease is so terrible in its results, most intelligent physicians are accustomed to drop into each eye of a new-born baby, from a medicine-dropper, one drop of a two per cent. solution of nitrate of silver, or some other salt of silver, or a few drops of a solution of boric acid. This is done as a matter of routine as soon as possible after birth, no matter what the condition, or surroundings, or habits of the mother may be. In some States such practice is urged or required by the government, and it ought to be required everywhere as a measure of prevention. It is a pleasure to record that eye diseases and blindness in infants have diminished greatly since this useful precaution was recommended by Dr. Crédé.

INDIGESTION IN INFANTS.

This may be considered a general term in infantile diseases, and it is probably more responsible than any other cause for suffering and death.

What does it mean? It means that some food substance has been administered which the baby's stomach and intestines have been unable to digest and absorb. We will dismiss from consideration at once all the substances that can be digested only by mature organs, and that only foolish and unwise parents will attempt to give to their babies. We will dismiss also the various preparations of cereals, which are seldom, if ever, proper during the early months of life, and for the use of which, during the subsequent months, no general rule can be laid down. It is very unwise to depend upon advertisements, pictures, and the recommendations of friends, in a matter so delicate and important as the selection of a suitable food for a sickly infant. Even if we were to admit that all that is said in these advertisements and testimonials is true (which is not the fact), it by no means follows that any particular baby would be improved by food that had helped others. This remark applies equally to all forms of cereal food, whether manufactured and patented or otherwise, and it is manifestly improper to endanger the life and health of young children by dependence upon commercial recommendations rather than upon the knowledge and experience of physicians. If a physician deems it wise to prescribe an artificial food, he assumes the responsibility for its use. and with him that responsibility should rest.

MILK AS FOOD FOR INFANTS.

There remains to be considered the food substance milk, especially cows' milk, which is always procurable, and even in cities and among the poor can now be obtained in a reasonable condition of freshness and purity, thanks to the efforts of many physicians and philanthropists, and the assistance of the boards of health. One need only refer to what has already been said concerning the pasteurizing of milk, especially for use among the poor, and those who are unable to obtain their milk supply directly from the dairyman. It is desirable, when possible, that milk should be delivered to the consumer in glass bottles, and it goes without saying that these bottles should be absolutely clean and sweet. If they are not so, the milk is sure to be contaminated, no matter how good its original quality may have been. The ordinary person can not tell whether milk is fresh or not, and it is not absolutely essential that he should. Of course, milk that has been drawn recently, will remain sweet longer than that which has been kept, especially if it has been stirred up by a long railroad journey.

WHEN MILK CAUSES INDIGESTION.

It is especially important that milk should be kept cold to prevent it from souring; and when it has become sour to the smell, or taste, it is no longer suitable as a food for infants. If used as food it will produce indigestion, and indigestion will be shown by the several conditions that will presently be considered.

Milk may be contaminated by various substances that the cow has eaten, such as poisonous plants, swill or garbage, or by impure water that she has drunk. It may also contain the germs of tuberculosis, typhoid fever, scarlet fever, and possibly of other diseases. No animal is a greater sufferer from tuberculosis than the cow, and unfortunately it may not always be possible to detect the disease until much harm has been done. This emphasizes the importance of constant watchfulness over the sources of the milk supply.

SIGNS OF INDIGESTION.

In order that cows' milk may not produce indigestion, it must resemble human milk as nearly as possible. The principal differences between those two varieties are that human milk contains more sugar and less cheese (casein) than cows' milk. In preparing cows' milk for infants' food, it is therefore necessary to add water, according to the richness of the milk and the age of the infant; to sweeten it with fresh milk sugar, and sometimes to increase the supply of fat or butter it contains by addition of cream. The addition of water diminishes, of course, the proportion or percentage of cheese. A small quantity of baking soda may be added to make the milk alkaline, which is a matter of importance. If the milk is alkaline, it will turn a small strip of red litmus paper to blue; if it is acid, it will turn a strip of blue litmus paper to red.

An infant has difficulty in digesting the cheese that is in milk, for its gastric juice is not sufficiently strong for this purpose; and if there is too much cheese, or casein, in its milk, it will either be vomited in the form of curds, or appear in the stools in that form. Cheese, therefore, is the principal cause of indigestion in infants.

SIMPLE TREATMENT FOR COLIC.

Colic properly means pain in the large intestine, but the word is commonly used to refer to pain in any portion of the digestive tube, from the stomach to the end of the bowel. An infant can not talk, it can only cry; but crying does not always indicate pain, or colic. If an infant has a bad temper, and this may appear very early in life, the crying may be excluded as a positive evidence of colic. An infant may also cry if it is hungry, and it is not usually difficult to determine that this also is not a cry of pain. But if, with the crying, there is also vomiting of sour or curdled milk, if the abdomen in hard and distended with gas, and the stools are curdy and offensive, if the feet are cold and the body is hot, it will be safe to say that the baby has colic. Then one should inject from a fountain syringe (not from a syringe that pumps air into the bowel) half a pint of fairly hot, soapy water containing a teaspoonful of peppermint water. If the baby is not relieved in half an hour, give him half a teaspoonful to a teaspoonful of castor oil, mixing it, if desired, with some kind of aromatic water to disguise the taste. The intestines having been thoroughly emptied, investigate the question of milk, in which the counsel of a wise physician will be of great value.

CONVULSIONS—CAUSE AND REMEDY.

There is no mistaking the appearance of this unwelcome visitor; the muscles become rigid and then relax, the eyes are upturned, the skin may become dark or very pale, and the poor mother becomes terribly frightened. But babies seldom die in convulsions, for these are usually caused by something in the food that has produced indigestion; the nerves have become poisoned, and they are expressing their discomfort in this manner.

Investigate the food at once, dilute the milk still further, or add cream; if the mother is nursing the baby, she must stop eating indigestible food; or, as a last resort, she must wean the child.

As to the convulsions, the baby should be placed in a tub of hot water—not too hot—as soon as the muscles begin to be rigid. The child should be kept in the bath until the muscles are relaxed, and then a teaspoonful of castor oil should be administered, followed in about two hours with an injection of a pint of soapy water. Instead of the warm bath, the infant may be wrapped in a towel moistened with warm mustard water, a tablespoonful to the quart, a napkin moistened with cold water being applied to the head. If the convulsions are not due to indigestion, but are epileptic, the sooner the child is placed under the care of an expert in nervous diseases, the more hopeful will the outlook be for a permanent cure.

DIARRHŒA AND ITS CAUSES.

This is the deadly foe of infants, especially in summer, and is the cause of a large number of deaths. An excessively hot summer, whether moist or dry, is bad for infants. Whether the heat, by itself, will cause diarrhœa is a disputed question. Some medical writers say that it will not, but there are many cases of infantile diarrhœa, in which it is the only cause that can be discovered; but if the children are removed to a cooler atmosphere, especially to the seashore, they will improve rapidly, which is certainly convincing proof that the heat had something to do with the trouble. But if improper food be added to the heat, we have an explanation of most of the cases of this disease.

Children that are neglected, especially among the poor, are frequent sufferers from this condition. The stools may be loose and watery, they may contain particles of undigested milk, and sometimes they contain blood. They may be slimy, green, and offensive, and may be passed with little effort, or with force and straining. The head will be hot, and there will be a certain degree of fever; there may also be convulsions and vomiting. The child cries almost constantly, sleeps little, and suffers much pain from the gas that is formed in his intestines. The number of stools may not be more than five or six a day, or there may be as many as twenty. The pulse is rapid, the tongue coated and the breathing very frequent.

Such severe symptoms quickly sap the child's vitality and he may die within a few days; but if he is strong and vigorous, he may hold out for weeks. On the other hand, the symptoms may all disappear within a few days, and the usual health be quickly regained. The nursing and care of such cases are so much better than they used to be that mortality has been greatly reduced. Germs play an important part in this disease, for they are taken with the food, and rapidly develop in the stomach and intestines. Children that are nursed are far less likely to suffer from summer diarrhœa than are others. The treatment is the most important consideration.

REMEDIES FOR DIARRHŒA.

The first thing to be done is to keep the child as cool as possible, removing him to the seashore or the mountains, when it can be done. Very little clothing should be worn, and it should be loose and soft. Baths in lukewarm water should be given frequently, and the discharges must not be allowed to dry upon the body and irritate the skin. The milk must be pasteurized, and, if the diarrhœa becomes severe, it may be necessary to withdraw milk entirely, if the child has passed the second or third month. In place of milk one may give warm water, rice-water, barley-water, or egg albumen water, for a few days. As the condition improves, one may gradually return to the milk diet. Injections of warm water containing peppermint, or some other aromatic, may usually be given with comfort two or three times daily. A suitable dose of castor oil should be administered at the beginning of the disease, and five grains of bismuth two or three times a day. The blackening of the stools by the bismuth need not cause surprise or alarm. If the pain is severe, ten or fifteen drops of paregoric in a tablespoonful of warm water, or a similar quantity of camphor-water, may be given; but it should not be repeated more than once or twice without a physician's advice.

TEETHING.

In perhaps half of all cases, the teeth break through the gums without causing any great discomfort. In the remainder there is more or less pain, and there may be convulsions, though the teeth may not be entirely at fault in producing them. A teething child may be peevish and fretful, which is perfectly natural, for his mouth is sore, and he can express his feelings only in this way. The treatment is almost always very simple. A clean, hard rubber or ivory ring to press against the swollen gum will often give relief. If the gum is very hard, it may be necessary to make a small incision in it, but this is no longer done as a routine practice. It is very essential that the bowels be kept freely open, especially if the child is feverish; half a teaspoonful of Rochelle salts may be given in an ounce of warm water.

SOME COMMON DISEASES OF CHILDHOOD AND YOUTH.

Not all of the following diseases are peculiar to childhood, but occur at other periods of life. To most of them, however, children are more susceptible than adults, and some are classed as distinctively "children's diseases."

APPENDICITIS.

This disease is by no means limited to childhood, but every physician of experience has seen many cases of it among children. It frequently begins with an attack of indigestion, in which the chief symptoms are nausea, vomiting, abdominal pain, and diarrhœa. It may begin also with constipation, with intense pain, and rigid abdominal muscles. In many cases it is impossible to trace the cause. Fever and rapid pulse are usually present, and, if the case is one of true appendicitis, there will always be a peritonitis with it. The most sensitive spot is on the right side of the abdomen, midway between the navel and the upper edge of the right haunch bone. As the disease develops, the pain in the right side will increase. If an abscess is forming, a lump or hard mass can often be felt in that location. This disease is a surgical one, and is always treacherous. It can sometimes be quieted by the use of an ice-bag over the region of soreness, but one should not forget that such quieting usually affords only temporary relief. Opiates will relieve the pain, but will also mask the developing disease, and give a false sense of security. The only proper treatment, after the disease has been clearly made out, is a surgical operation and the removal, if possible, of the diseased organ. When the operation is performed at an early period, amid good surroundings, and by a competent surgeon, it usually results in the prompt recovery of the patient.

BRONCHITIS.

This means an inflammatory condition of the lining membrane of the bronchial tubes which are distributed through the lungs and convey the air to the air cells. It usually attacks both lungs, and involves sometimes the larger, and sometimes the smaller tubes. In the latter case, it is called capillary bronchitis, and is exceedingly dangerous, especially in very young children.

If you place your ear on the chest of one who has bronchitis, you will always hear rattling, gurgling, or hissing sounds, as the air of respiration tries to pass through the obstructed tubes in entering or leaving the lungs. Sometimes there is a spasm of the bronchial tubes, and then breathing becomes very difficult, this particular condition being called asthma. There may or may not be a profuse collection of mucus in the tubes, which is coughed up and spat out.

This disease is very common in the months of winter and spring, and is particularly prone to follow exposure to cold and wet. It may occur at any age, in either sex, and is especially prone to attack delicate children who have a tendency to tuberculosis. It usually lasts one or two weeks and may develop into pneumonia. It is often associated with measles, grippe and certain forms of heart disease.

The cough should be soothed, and expectoration favored by suitable doses of heroin, hero-terpin, or syrup of wild cherry, half a teaspoonful to a teaspoonful being given in water three or four times daily. Cod-liver oil should be taken as a tonic, and, if there is high fever, a flannel band, or a plaster of antiphlogistine, covering the back and front, should be worn several days. The bowels must be kept open with castor oil, or a saline laxative, like Hunyadi or Apenta water. In mild cases, very little treatment will be necessary; the child should be kept at home, and, if necessary, in bed, until the cough and fever abate.

CHICKEN-POX.

This disease is usually a very mild one; the child may not even complain of feeling ill, or there may be moderate fever in addition to the eruption. The latter consists of small blister-like formations, which appear in successive crops over the entire body, but particularly on the back and shoulders. The blisters quickly dry, and form scabs which will soon drop off. New blisters form while the old ones are drying. This disease is very contagious, and requires about two weeks for its development after the germs have been received. The patient should be kept apart from other children, until the eruption has disappeared. There is seldom any scarring from it. The bowels must be kept open, and the child cautioned against scratching himself. A daily warm tub-bath will hasten the development of the disease, which is desirable, as the sooner the eruption is "brought out," the sooner the trouble will be over.

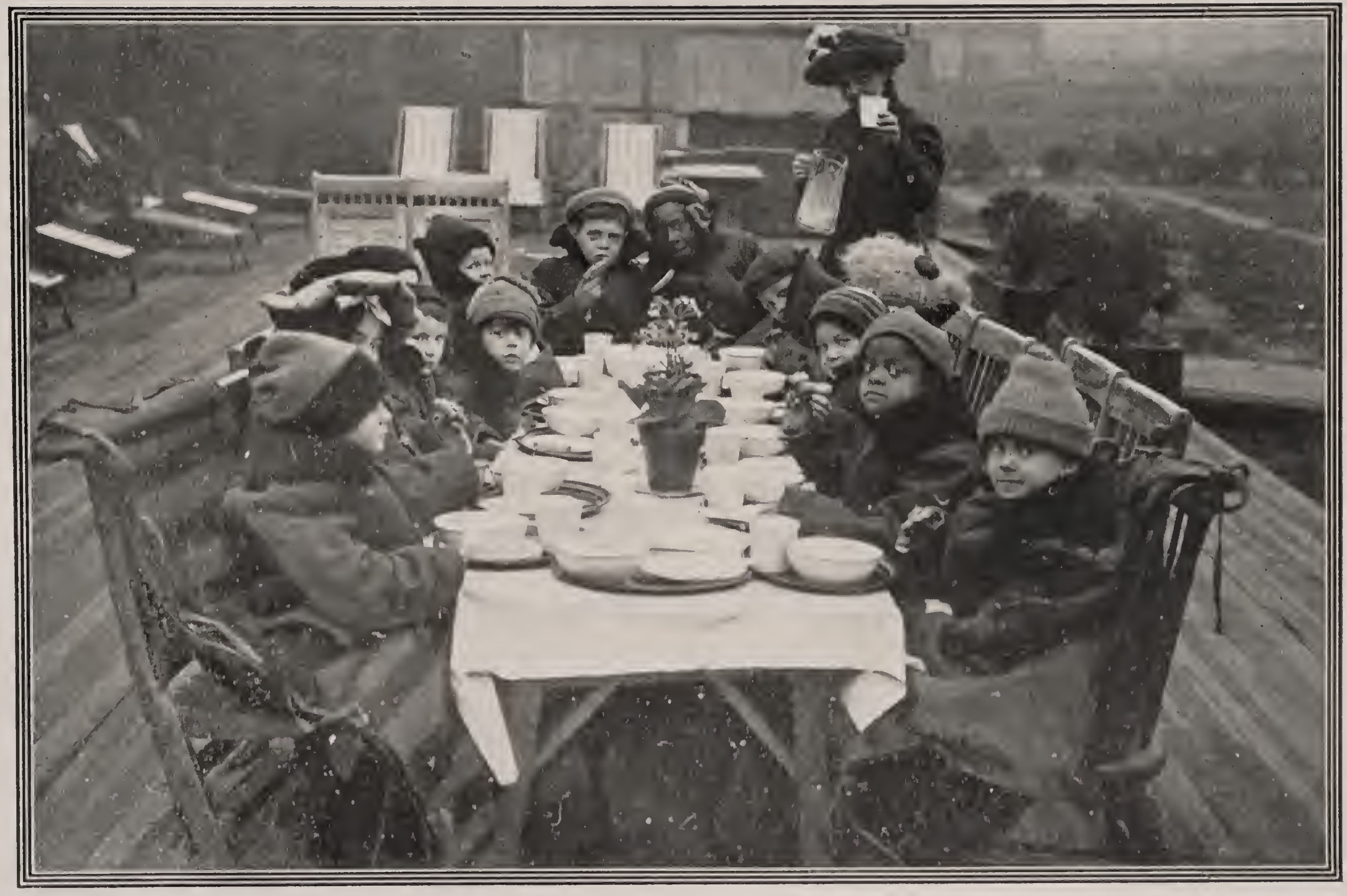
COLD IN THE HEAD.

Nasal catarrh is a more correct name for this condition which is characterized by a copious discharge from the nose, and sometimes from the eyes. There may also be swelling of the mucous membrane of the nose, with inability to breathe freely through it. Fever may also be present, with rapid pulse and general discomfort. If the case is a mild one, the child need not be removed from school. If it is severe, it will be better, for fear of complications, to keep him at home.

A warm bath should be given at the beginning of the attack, the bowels opened with a mild laxative, and vaseline or oxide of zinc ointment applied to the nostrils. If the fever is high, a few drops of tincture of aconite may be given, in one-drop doses, at intervals of one hour.

CONSTIPATION.

This may result from a natural inability of the muscular layer of the bowel to contract properly, and expel



CHILDREN ON A HOSPITAL ROOF.—Dinner hour for sick children who are being treated by the out-of-doors method. From a copyright photograph by Underwood.

its contents, or it may be due to carelessness of the mother in bringing up the child, or to carelessness and inattention on the part of the child itself.

The consequences are often so far-reaching, on account of the absorption of poisonous material, that mothers can not be too particular in impressing upon their children the importance of the daily visit to the toilet. To correct this condition, careful attention must be paid to at least three things—exercise, diet, and laxative medicines. Out-of-door exercise in abundance should be insisted upon for every child who is not sick. The diet should be simple: milk, cereals, eggs, soups, fresh vegetables, a minimum of meat and fish, and a minimum of sweets, desserts, and rich food of all kinds. Fatty and fried foods, hot and poorly baked bread of all kinds, must be avoided. The heartiest meal should be at noon, and not at night, and the child should not be put to bed immediately after eating. There are innumerable medicines for the relief of constipation, such as castor oil, especially when the tongue is coated, and the breath offensive; rhubarb and soda mixture, compound cathartic pills, cascara sagrada, and many others. It is not easy or wise to prescribe without knowing the particular conditions; and the matter is of so much importance that the advice of a physician will be very useful in deciding just what medicine is suited to a particular case.

CROUP.

This is a common affection in young children, and the terror of young mothers. It was formerly the custom to divide it into the spasmodic variety, and the one in which a membrane is formed upon the vocal organs; but the latter is now usually regarded as diphtheria, and treated as such. The spasmodic form is common with children from two to eight or nine years of age. It usually begins without previous warning, after the child has gone to bed. He is awakened, after a few hours of sleep, by difficulty in breathing, and with a harsh, metallic cough. The difficulty in breathing may be so great that he seems in danger of suffocation. He should be allowed to sit up in bed, or in a chair, and the spasm in the vocal organs should be relaxed as quickly as possible. Emptying the stomach will, in many cases, be all that is necessary, and this may be done by giving the child a glass of lukewarm water containing half a teaspoonful of mustard. If vomiting does not promptly bring relief, a teaspoonful of syrup of ipecac may be given, followed, if necessary, by another in half an hour. Good results rarely fail from such treatment which is far less trying than the old method of using very powerful and exhausting remedies, or in covering the child with goose-grease. There is no particular harm in rubbing the latter into the skin of the chest and throat, but it is an unpleasant procedure, and no more effective than the one mentioned.

DIARRHŒA AND DYSENTERY.

These are separate and distinct diseases, but both are characterized by copious watery discharges from the bowel. In dysentery there is also painful straining, a discharge of mucus and blood, and a sore or ulcerated condition of the lower end of the bowel. An ordinary diarrhœa may be caused by a sudden change in the weather, especially from cold to heat and humidity, but it is most frequently due to improper food, to prolonged constipation, etc. Germs and bacteria play an important part in producing both diarrhœa and dysentery. When there is reason to believe that improper food is the cause, it is always well to administer one or two teaspoonfuls of castor oil or laxol, giving first a small piece of lemon, then the oil, and then another piece of lemon, if the taste of the oil is objectionable.

The patient should be kept as quiet as possible, preferably in bed. The food should be simple, such as boiled milk, gruel, toast, etc.

If there is mucus or blood in the stools, the rectum should be carefully washed out once daily, or oftener, a pint of hot water as hot as can comfortably be borne being allowed to run slowly into the bowel from a fountain syringe. To the water may be added a teaspoonful of tannin, or half a teaspoonful of powdered alum, or half a teaspoonful of paregoric, the medication depending, of course, upon the severity of the case, and the age of the child. If there are gas and pain in the intestines, half a teaspoonful of paregoric, or a teaspoonful of camphor-water well diluted with water, may be given by mouth. If relief does not come in a few days, it will be necessary to advise with a physician, for the giving of powerful medicine without such advice is improper.

DIPHTHERIA.

This is one of the most serious and fatal diseases to which children are subject. It usually begins two or three days after exposure to the poisonous germ which causes it, which is known as the Klebs-Loeffler bacillus. Vomiting, fever, and general discomfort are among the first symptoms, and the throat is sore. A patch of gray or brown membrane may be seen, on examination; one or both tonsils may be surrounded by an area of redness, which quickly extends to the surrounding portions of the throat, often spreading downward to the larynx, or upward to the nose, or to both. It sometimes begins in the nose, and works downward. The glands in the neck are enlarged, and the tissues are hard and swollen. The child grows worse rapidly; the breathing becomes harsh, and very difficult; the breath is usually very offensive; the skin is sallow; the heart action weak.

The distinction between this disease and tonsilitis, or quinsy, is sometimes difficult to ascertain, even for a trained physician. If there is any doubt in the case, it had better be treated as if it really were diphtheria, for the disease, if not checked, may result fatally. Adenoids and enlarged tonsils predispose a child to this disease. It is so very contagious that the most rigid quarantine should be observed. The sovereign remedy for its treatment is antitoxin, which should be given in doses of about five thousand units, as soon as the disease is discovered. It may be necessary to repeat the dose once or oftener, according to the development of the membrane, and the general condition of the patient. When the antitoxin acts favorably, the membrane will shrivel, and gradually disappear. A portion of the membrane should be removed and examined by a bacteriologist, from time to time, to note the disappearance of the deadly germs it contains.

Gargles of carbolic acid solution or some other antiseptic should also be used frequently, and brandy, whiskey, ammonia, or camphor given in suitable doses to sustain the action of the heart.

In some cases a tube is passed into the larynx through the mouth, and worn until the danger from suffocation is passed; this process is called intubation. Formerly it was the custom to make an incision into the windpipe, and insert a suitable tube from without, this operation being called tracheotomy; but it is now seldom found necessary. The disease continues a week or longer; and great care should be used to prevent complications of the heart, kidneys, and lungs. Good nursing, rest in bed, careful liquid diet, and antitoxin, will bring about a cure in the majority of cases.

DISEASES OF THE EYE AND EAR.

Various forms of these diseases are common among children, and they require skilled treatment. Mention has been made in Chapter XXXIII of the injuries to the eye and ear from foreign bodies, and also in the early portion of the current chapter certain statements were made concerning eye diseases in infants.

There is often a copious discharge from the eyes in connection with cold in the head, grippe, measles, etc., and there is a very common catarrhal disease of the eyes called conjunctivitis in which there is a profuse discharge of mucus, and sometimes of pus or matter. This may be produced by sand, dust, or disease germs in the air. It is often very annoying, and must be treated chiefly by cleanliness, a soft and clean piece of muslin or cheese-cloth being used to remove the discharge. The eyes must not, on any account, be rubbed or scratched. A few drops of boric acid solution, or some other mild antiseptic, should be gently instilled into each eye every two or three hours, from a medicine-dropper, until the discharge disappears.

Running or catarrhal discharge from the ears is also a very common condition with children. It may be associated with headache, pain in the ear, and swelling and tenderness of the bone under the ear, called the mastoid bone. In the latter instance it is always imperative to know whether the disease called mastoiditis is present, for this requires a serious surgical operation, which must be performed promptly. No time should be lost in temporizing in these important conditions; home treatment and delay often have serious consequences.

Wax in the ear is also very common in children, and may cause pain, buzzing, and deafness. Absorbent cotton moistened with hot sweet oil may be gently placed in the opening of the ear and a bag of hot water, or salt, or sand laid against the ear. The sure remedy is to irrigate the ear with a stream of hot water until the plug of wax is washed out. This is not an easy procedure for one who is unaccustomed to such work.

FITS.

This disease is properly known as epilepsy, and is due to a disordered condition of some portion of the spinal cord. It is similar to the condition described as convulsions in infants; in some cases the two are identical.

No one who has seen a person in a fit is likely to forget it. It may come on suddenly or gradually. Sometimes the individual has warning of its approach, by the feeling of a lump in the throat, dizziness, swimming of objects before the eyes, etc. Then, perhaps after a loud shriek or scream, unconsciousness occurs, with pallor or blueness of the skin, twitching of the muscles over a certain area of the body, often with biting of the tongue. Gradually the twitching becomes less violent, the muscles relax, perspiration is profuse, and within two or three minutes from the time the attack began, consciousness returns, usually with a feeling of great weakness. An attack may be precipitated by intestinal worms, indigestion, fear, and a variety of other causes. When the attack has occurred, the principal thing is to prevent the patient from injuring himself as he falls or throws himself about. His clothes should be loosened, especially around the neck and waist, and a cork or some other suitable object should be placed between his teeth, to protect his tongue.

After consciousness has returned, ammonia, camphor, or some other stimulant may be given. The treatment of the diseased condition is often very unsatisfactory. Careful regulation of the diet, and of the bowels, is very important, for medicines are usually of little value. Bromides are often given in large doses, and are sometimes beneficial, but their use has its disadvantages. The best plan is to place an epileptic, when possible, in a suitable sanitarium, where his symptoms can be carefully watched. A considerable percentage of cures has followed such treatment.

GRIPPE.

It is about twenty-two years since this troublesome epidemic disease began to be very prevalent in the United States. During the first few years of its appearance it had no serious symptoms, and seemed quite like a severe cold or influenza; but in recent years it has taken different and more severe forms. In addition to the catarrhal condition of the nose and throat, there is often great physical prostration, with fever and rapid heart action; and not infrequently the disease is accompanied by evidences of profound poisoning, resulting from the action of the germs by which it is caused. Rheumatism of varying degrees of severity frequently follows it, especially among young children; and there are many cases in which it has been complicated with serious heart disease, and diseases of the ear. It is, therefore, one of those maladies in which the type and symptoms are changing, and which promises much trouble for the future. The treatment must, in all cases, be what is called by the doctors *supporting;* rest in bed, abundance of sleep, fluid diet, such as milk, soups, and gruels. The bowels and kidneys must be kept active, the former by daily doses of mild laxatives, and the latter by abundant draughts of water, weak tea, milk, etc. Small doses of tincture of aconite (one drop), or quinine (two grains), may be given two or three times daily for the fever; while the pains in the muscles and bones can usually be relieved by suitable doses of phenacetine and salol, two grains each, two or three times daily. In view of its complications, it will be desirable, in most cases, to have medical advice, for no one can predict at the beginning what the outcome of such a case may be.

HEADACHE.

This is a symptom and not a disease. It is present in many of the diseases from which children suffer, in a mild or a severe form. It is often an evidence of disturbed digestion, eye strain, poor nutrition, kidney disease, and also the result of injuries of various kinds. Only the most general advice for its treatment can be given. It is safe to say that, when the skin is hot and dry, ice-cold cloths upon the head will be very soothing. Applications of ammonia, camphor-water, or of bay rum upon the head and face, are also very grateful. If it is due to indigestion, and especially when it is accompanied with dizziness and disturbed vision (sick headache is its ordinary name), the plain indication will be to empty the stomach and bowels with castor oil, or with one or two compound cathartic pills.

When there is only a soreness of the face and head, it may usually be considered a neuralgia or nerve pain, and the painful region may be rubbed frequently with a menthol pencil. Phenacetine in small doses, will often relieve it, but the use of this, and other coal-tar drugs, is not unattended with danger.

DISEASES OF THE HEART.

Quite a number of diseases affect this vital organ in children, all of which are serious, though some may be entirely overcome. When the structure of the heart is defective at birth, a certain portion remaining open which should have closed, the child's skin is constantly blue, and it seldom lives beyond the first or second year. Such cases are hopeless. Children who have scarlet fever, grippe, erysipelas, rheumatism, and other infectious diseases, often recover from them with weakened or imperfect heart. Heart disease may develop also in connection with disease of the lungs and kidneys, and as a result of bad nutrition.

The principal forms of disease of this organ, are those that affect the muscles, the valves, and the inner or lining membrane. The sac (pericardium) in which the heart is inclosed, is also not infrequently diseased. The first variety is rare. It is very likely to be associated with congested circulation in the lungs, with effusion of fluid into the joints and cavities of the body, and other serious conditions, and is very often fatal.

Inflammation of the lining membrane of the heart often follows rheumatism, and is due to the influence of germs. If this membrane becomes ulcerated or sore, poisonous material is taken up by the blood, and carried over the body, and death usually results in a few days or weeks. Valvular troubles form the majority of cases of heart disease in children. The valves, or the valvular openings, may become too small, the whole circulation then being thrown into greater or less confusion. If, in consequence of valvular trouble, the blood is detained in the veins, or in the lungs, we get blueness of the skin, difficulty in breathing, inability to make exertion, etc. When the heart action is weak, and it is unable to pump the blood through the arteries, we may have pallor of the skin. Sometimes the action of the heart is irregular, a beat being lost or doubled, or otherwise changed. If conditions are favorable, the valves or the openings may be restored to their normal state, or the structure of the organ may be changed so as to meet the new conditions. Sometimes the heart dilates or expands, suddenly or gradually. This is always a very dangerous symptom. The entire subject is a very complicated and serious one, and calls for the best advice that can be had. It would be improper to direct home treatment of any kind, except after careful examination to determine the exact condition of the organ.

INDIGESTION IN OLDER CHILDREN.

Children are frequent sufferers from this condition, but less so than is the case with infants. It may be due to overeating or to the use of improper food, such as green apples, pork, an abundance of fried food, stale fish, bad milk, and a host of other substances. The symptoms may be mild or severe. Sometimes there is only a diarrhœa which is promptly relieved, when the offending substance is removed from the stomach and bowels. In other cases, in addition to the diarrhœa, there are nausea and vomiting, and in still others, intense pain in the bowels. In the severest cases, a peritonitis is excited which may result in appendicitis and require a surgical operation.

The child should in all cases be kept in bed; heat should be applied to the feet and abdomen, and, if there is nausea, a glass of lukewarm water containing half a teaspoonful of mustard should be given to produce vomiting. If this does not bring relief, a dessertspoonful, or a tablespoonful of castor oil, according to the age of the child, may be given. If the pain continues, half a teaspoonful to a teaspoonful of paregoric in a wineglass of water, may be administered, and repeated in half an hour, if necessary. If this should prove ineffectual, and fever and restlessness be present, the condition will be one calling for skilled attention, for if appendicitis is developing, it may proceed so rapidly that perforation of the appendix will take place, unless surgical measures are promptly resorted to. There have been many such cases in children in which an attack of indigestion was the only exciting cause of appendicitis that could be found. If an operation is performed early in these cases, the result will almost always be favorable.

INFANTILE SPINAL PARALYSIS.

This disease has greatly increased in frequency within the past few years. In some localities it has prevailed extensively as an epidemic. It occurs principally in children under ten years of age, though adults sometimes suffer from it. It is probably due to some kind of germ. It attacks children suddenly, in some instances after lying upon the damp ground. Its prominent symptoms are fever and paralysis of one or both limbs. Sometimes the upper extemities and other portions of the body, are paralyized. Its severe symptoms last three or four weeks, and then improvement begins. Gradually the use of the muscles is restored, but, in most cases, some of them remain permanently shriveled and helpless. Very often one of the lower extremities remains paralyzed, the foot being dragged helplessly along. Death seldom results from this disease. Electricity is often employed in an endeavor to strengthen the muscles, and it should not be omitted as a means of treatment.

When some of the muscles that are attached to the foot partially regain their power, a surgical operation is occasionally possible which, by changing their insertion and the direction of their mechanical action, may overcome, to a certain degree, a very troublesome deformity.

INTESTINAL WORMS.

These troublesome parasites are not so common among children as they formerly were, probably due to the fact that greater care is now used in preparing children's food.

The principal varieties of intestinal worms are tape-worms, large round worms, and small pin or seat worms. The first of these varieties is seldom seen in children; the second is rather more common; and the third is the most common of all.

Children who are sufferers from worms have, in the intestines, more or less pain, which is sometimes associated with diarrhœa, and often with intense itching of the skin at the intestinal opening. Sometimes there is fever, and, with very young children, there may be convulsions.

Tape-worm is discharged from the bowel in the form of a flat band, which resembles a band of tape. It is composed of segments about an inch long, and a piece from a foot to several feet in length may be discharged with the stools. The worm grows very rapidly, and the expulsion of its parts may continue indefinitely, until the head is removed.

Round worms resemble ordinary earth worms; their location is in the rectum, and there are seldom more than half a dozen of them at any given time.

Seat worms are small white objects about an inch in length, and are also located in the rectum. Lumps containing large numbers of them may be passed with the contents of the bowels, and they are sometimes found on the skin that surrounds the intestinal opening. They multiply in the bowel in great numbers, and cause intense irritation.

The removal of tape-worm is an important matter; the medicine required for its destruction is poisonous, and should be prescribed only by a physician.

The other varieties are more easily disposed of. For twenty-four hours the patient to be treated should fast, or take nothing more than a glass or two of warm milk. On the morning of the second day a tablespoonful of castor oil should be given, and no solid food taken during that day. After the bowels have been thoroughly emptied, a pint of hot water containing a teaspoonful of boric acid should be slowly injected into the rectum; and this will usually be all the treatment required. It may be repeated, should there be further evidence that all worms have not been removed.

MALARIAL FEVER.

Children are very sensitive to malarial poisoning. The cause is now known to be a germ called plasmodium which develops and multiplies in the blood, producing the well-known symptoms. This germ is introduced with the bite of a particular variety of mosquito, and it is said that it comes in no other way, but there have been numerous cases in which it would be difficult to trace the disease to such an origin. It is quite possible that the germs may remain undeveloped in the blood a long time, and become active only when the conditions are favorable for such development. In that way the mosquito may be made responsible in cases that are obscure as to their cause.

Malarial fever is common in swampy and badly drained localities. It is most prevalent in the country, but it also occurs in cities, especially when the earth is dug up for street paving, or for building or other purposes. The disease may occur with preliminary symptoms of discomfort, or it may come suddenly and without warning, and at any hour of the day or night. What is called a malarial paroxysm consists of a chill, followed by a burning fever, this being followed by a profuse perspiration. The chill may last from a few minutes to an hour or longer; the teeth chatter, the whole body shakes, and it is almost impossible for the patient to get warm. A high fever quickly follows, usually with headache, mild or intense; and, as this gradually subsides, the whole body is bathed in perspiration. This paroxysm may be repeated on the same day, or on successive days, or on the third or fourth day, according to the intensity of the poisoning.

There is one sovereign remedy for malarial poisoning, and that is quinine. It destroys the germ of the disease more effectively than any other substance. Its administration should be begun as soon as possible after a paroxysm has ended, and continued as long as any evidences of the disease remain.

In giving it to children and youths it will seldom be necessary to use more than five grains at a time, night and morning. The dosage must be regulated by the severity and frequency of the paroxysms, and the quantity should be diminished when the patient complains of buzzing or ringing in the ears. It may be given with chocolate or other substances to lessen its bitter taste, and it must be remembered that its effect upon the sense of hearing, is sometimes bad.

MEASLES.

This is one of the infectious, contagious diseases, and is perhaps the most common of those known as the diseases of children. It usually occurs prior to the tenth year. It is of such frequent occurrence that mothers sometimes say they wish their children ''would have it, and be done with it.'' It may run so mild a course that the child is scarcely conscious that he is sick, or it may be severe and even fatal. Its period of development, after the germs have been received, is from twelve to twenty days. The symptoms begin with fever, cold in the head, running from the eyes and nose, and sometimes with a dry cough. In from one to four days a rash in the form of round elevated spots, with reddened skin between them, breaks out on the face, neck and back, then spreading over the entire body, the hands being attacked last. This continues from three to five days, gradually fades away, and then peels off in tiny scales during the following week. There is sometimes much swelling of the skin, especially that of the face.

When the disease is of a severe form, the spots are very dark, owing to the escape of blood into the skin, this form being known as ''black measles.'' The patient may be very restless, or drowsy and stupid; there is copious diarrhœa, and the cough is hard and troublesome, sometimes developing into pneumonia and tuberculosis. Fatal cases are usually those that occur in children under four years of age. The disease is contagious from first to last, the germs being sometimes carried by clothing.

If the fever is high, small doses of tincture of aconite, one drop five or six times daily, should be given. The entire surface of the body should be covered daily with vaseline, lanoline, or cocoanut oil. Small doses of heroin or paregoric, five to ten drops, may be given every few hours to relieve the cough.

German measles is very similar to the foregoing in its symptoms. There is seldom any cold or cough, and all the symptoms are mild. The disease is over in a few days, and the child frequently does not feel sick enough to bear with patience the necessary quarantine, which should last at least one week.

MUMPS.

This also is a contagious disease of children, but it is not nearly so contagious as measles. Its period of development is usually from two to three weeks.

The disease consists essentially in swelling and inflammation of the salivary glands below each ear, called the parotid glands. One or both of them may be involved, together or in succession, and the glands in the neck may also be swollen. It is not unusual for the testicles in boys, and the ovaries in girls, to be inflamed at the same time with the parotid glands. The latter are very tender to the touch, the flow of saliva is diminished, and the mouth is dry.

Not much treatment is necessary, but the child must be kept at home, and apart from other children. The bowels must be opened daily, the diet should be light, and, if the glands are very sore, they may be rubbed frequently with warm camphorated oil.

NIGHT TERRORS.

Many children suffer from this condition, especially in early childhood. It may be simply a nightmare, the child awakening in a fright, but with mind clear. He may be so terrified and excited that it will be an hour or more before he becomes calm and goes to sleep again. Or he may be found sitting up in bed, terrified by imagining that he sees a brilliant red object or a wild animal. He may not realize his situation, and may not remember anything about his fright the following day.

The first variety is often due to indigestion, to a hearty meal at night, or to some exciting experience. Children with adenoids, and enlarged tonsils, are quite subject to such attacks. The second variety occurs in nervous, excitable children, and may be accompanied with the discharge of a large quantity of colorless urine, or associated with some form of nervous disease.

Treatment of the first variety will consist in careful regulation of the diet, a warm bath on retiring, and a gentle and soothing assurance at the time of the attack. Medicines should be avoided, if possible, and the adenoids and tonsils should be removed, if they are the apparent cause. The assistance of a specialist in nervous diseases should be obtained for the second variety.

PLEURISY.

This is an inflammation of the membrane that lines the cavities containing the lungs, which forms the outer covering of those organs. It is associated with or follows pneumonia, or it may occur without any considerable involvement of the lungs. It may be unaccompanied by the formation of fluid in the pleural cavity, or there may be an accumulation of watery fluid or of pus. Its symptoms, apart from those of the accompanying pneumonia, are severe pain on the diseased side, and great difficulty in breathing. The presence of fluid can be determined only by a physician.

If the fluid is watery, it may be reabsorbed as the patient gets well, though the pleura usually remains somewhat thickened. If the fluid is pus, it should be removed as soon as possible. In many cases it will be the only way to save life. The operation will consist either of an incision at the lowest portion of the pleural cavity, or in an incision, plus the removal of a portion of one or more ribs, so as to allow the poisonous fluid to drain away.

PNEUMONIA.

Physicians recognize two forms of this disease, one of which is called lobar-pneumonia and the other broncho-pneumonia.

In the former, the lobes, or masses into which the lungs are divided, are involved to a greater or less extent; while in the latter, only small patches of tissue around the bronchial tubes are attacked. Pneumonia means the throwing out of a great multitude of cells from the blood vessels of the lungs into the surrounding soft tissue, thus keeping the air vesicles from expanding, and therefore preventing the entrance of air into the affected portion of the lung, and the necessary aeration of the blood. Of course, when so much of the lung is thrown out of use that sufficient air can not enter, the patient must die of suffocation. Broncho-pneumonia is the usual form in children under four years of age, while lobar-pneumonia, involving a part or the whole of one lung, or a part or the whole of both, is usual in children older than four. Pneumonia is usually less serious in children than in adults, and does not usually last so long.

In both varieties, but especially the lobar, the disease may begin with a chill. There are fever and rapid heart action, and there is usually a cough. If the involvement of the lung is extensive, there will be expectoration of a dark material, rusty or bloody in appearance. The breathing becomes more and more rapid and difficult, as more lung tissue is thrown out of use.

There is no appetite, and sleep is disturbed and diminished. The mind may wander, and the patient present the appearance of one who is very sick. If the vitality holds out, the temperature will begin to drop, and the breathing to improve after a week, or longer, in broncho-pneumonia; while in lobar-pneumonia it often drops suddenly to normal, and remains there.

This disease is due to a particular germ, but its development is favored by exposure to cold and wet, by fatigue, and by association with bronchitis, measles, grippe, diphtheria, whooping-cough, diarrhœa; and it may occur after prolonged surgical operations.

The treatment must be supporting, as much liquid or other easily digested food as possible being given. Poultices and pastes upon the chest are often wonderfully soothing and helpful. If the breathing is difficult, inhalation of oxygen, or of steam from a croup-kettle, will be helpful. Few medicines will be necessary, the great requirement being to help nature out of a very trying situation.

RHEUMATISM.

This disease is by no means infrequent among children. True rheumatism means varying degrees of disturbance, and severe pain, in one or more of the joints of the body. Pains in the muscles are not properly rheumatism, though they may be akin to it, especially if the muscles are connected with joints.

In inflammatory rheumatism there is not only severe pain in the joints, but redness, swelling, fever, and often slight or copious effusion of fluid.

Rheumatism in children is most serious from the fact that it is very often associated with heart disease, especially that variety (endocarditis) which consists in inflammation of the lining membrane of the heart—a serious and often fatal disease. Other conditions frequently associated with rheumatism in children are St. Vitus' dance, tonsilitis, and adenoids.

The so-called ''growing pains'' are usually rheumatic, and they must not be disregarded. The disease may be due to cold, wet, fatigue, to exposure of various kinds, and especially to hereditary influence or tendency. Children that have rheumatism must always be favored and carefully watched. Disturbing tonsils and adenoids must be removed, violent exercise prohibited, and attendance upon school curtailed, if not given up altogether. Such children should wear woolen underclothing the entire year; their diet must be simple and wholesome, and they must have abundance of sleep; in a word, the care over them must be unremitting. In spite of such care and attention, death claims many.

Tonics of iron, quinine, strychnia, and cod-liver oil, are almost always useful. The great remedy for rheumatism is salicylic acid, especially in the form of its salt, salicylate of soda; but it often deranges the stomach, and should be given in the most palatable form possible.

RICKETS.

While this is especially a disease of the poor and badly nourished, it is not absent from the homes of the rich. It is a disease of malnutrition; its most notable symptoms are seen in the bones, especially the bones of the legs, which become bowed from inability to sustain the weight of the body; but it affects also the muscles, nerves, and internal organs.

Early symptoms are sweating of the head, restlessness at night, constipation, delayed appearance of the teeth, and "beading" of the ribs. The last mentioned symptom consists in a row of small lumps upon each side of the chest, where the ribs join the cartilages. A rhachitic child has other deformities besides those of the legs; the head is square and large, the chest may be sunken, and the spine unnaturally curved; the wrist and ankle may be enlarged, and there is often a catarrhal discharge from the mucous membranes. Sometimes the deformities of this disease persist, and sometimes they disappear, if the child reaches adult life.

Children with rickets are poor subjects for any kind of acute disease, such as might easily be tolerated by more robust children.

The cause of the disease is poor nutrition: too little fat, too much starch, too little lime, the latter causing the weakness in the bones. Want of sunlight and sleep, and unhealthy home surroundings, are also causative influences. Many of the immigrants from southern Europe to this country are, or have been, sufferers with this disease.

The treatment is often difficult to carry out because of the poverty of the patient. It should consist mainly in removal to healthy surroundings, plenty of good food, and plenty of cod-liver oil, together with a suitable preparation of iron. The syrup of the iodide of iron is often given to rhachitic children.

SCARLET FEVER.

This disease shares with diphtheria the unenviable distinction of being the scourge of childhood. It is one of the deadliest and one of the most treacherous of diseases. The symptoms begin within two or three days after the reception of the infective germs. A child that has apparently been perfectly well, may be suddenly attacked with a chill, followed by fever, vomiting, and sore throat. The back of the mouth and throat have a peculiar scarlet redness, while the tongue has a white coating and pink dots or spots scattered over it, forming what is known as the "strawberry tongue." Within twenty-four hours a scarlet rash or redness appears on the back of the neck and quickly spreads to all portions of the body, so that the child sometimes resembles a boiled lobster in color.

At the end of about a week, the skin begins to peel off, sometimes in scales and sometimes in large flakes, this process continuing three or four weeks, and ending with the palms of the hands and the soles of the feet. The fever remains high until the peeling process is well advanced; sometimes it disappears only to return again as violent as before, and this may be repeated several times. The throat is not only sore and red, but it may have a false membrane and diphtheria be combined with a disease which has already greatly taxed the patient's endurance. The ears are frequently involved with a middle ear inflammation which quite often results in deafness. The glands of the neck and other portions of the body may become enlarged, the joints inflamed as in rheumatism, and the kidneys disturbed, with chronic Bright's disease as the outcome. Many cases are fatal, while none are so mild that they should be treated with indifference.

The disease is caused by germs, and may be transmitted by anything that has been in contact with them. The germs are upon the skin, and when the latter peels off, the germs are carried with it. The patient, and the house in which he lives, should be quarantined at least six weeks.

The treatment should be supporting; no medicine is known that will effectually destroy the disease germs. The skin must be kept moist with daily warm bichloride spongings, after which the entire body must be rubbed with cocoanut oil. The bowels should be kept open, a mild laxative being almost always necessary. The diet should be simple and principally liquid. Sleep is very important, for, if it is disturbed and fitful, the patient's chances of recovery will be diminished. The various complications must be treated as they arise. A tonic containing iron, quinine, and strychnia will often be useful.

Children frequently suffer from eczema, prickly heat, and hives which are diseases of the skin.

ECZEMA.

This disease occurs frequently among children as well as among infants. It is usually the result of indigestion, the same as in infants. It may take the form of a redness of the skin, or there may be an eruption of vesicles with scales, scabs, and crusts. It is not always easy to distinguish eczema from other diseases of the skin. The idea that it should be left alone, or that it is dangerous to cure it from fear that it may "strike in," is foolish and irrational. Soothing lotions and ointments, in addition to careful regulation of the diet, are the chief considerations in the treatment.

PRICKLY HEAT.

This occurs in the form of bright red points or dots which are very abundant on the face, hands, and body. There is sometimes a fluid discharge from the eruption, and the itching is very annoying. The skin should be frequently dusted with boric acid or talcum powder, or it may be frequently sponged with vinegar and water, or with weak carbolic acid solution. A laxative of castor oil or Epsom salts should also be given.

HIVES.

This eruption consists of spots or blotches of a pale red color, distributed over the body and producing the most intense itching. It is almost invariably caused by indigestion. Shell-fish, strawberries, buckwheat cakes, etc., are common causes. The bowels should be thoroughly emptied, and the skin sponged with witch-hazel, vinegar, or carbolic acid solution.

SMALLPOX AND VACCINATION.

Now that vaccination is so generally practised, smallpox has become a rare disease, instead of the terrible pestilence which formerly caused one fifth of all deaths. Many physicians during years of practice, have never seen a case of it. Vaccination should be performed in infancy, and with material that is absolutely fresh, and then at intervals of five years, until adult life is reached. After that time it is seldom required, except as cases of smallpox appear in a community, when everybody should be re-vaccinated.

ST. VITUS' DANCE.

This is a common disease of the nervous system in early life, and occurs among sensitive, excitable children. It consists mainly of twitchings and contractions of the muscles of the head, face, neck, and limbs. They are entirely beyond the control of the patient's will, and are often due to excitement, embarrassment, fear, or fatigue. The disease may continue a few weeks, or it may extend through many months, with periods of improvement or disappearance. It is much more frequent in girls than in boys.

Children with this disease should be removed from school, should be kept as quiet and free from excitement as possible, and should always be treated with the greatest patience and forbearance. Harsh or unkind treatment will unfailingly intensify the bad symptoms. Diet is a very important matter, and constipation must be especially guarded against. The treatment with drugs must be regulated by an expert in nervous diseases. The disease sometimes results in a permanent disorder of the nervous system.

TONSILITIS AND ADENOIDS.

Adenoids are lumps or masses of soft, spongy tissue which grow upon the back portion of the throat, interfere with the breathing and hearing, and, in these and other ways, are very detrimental to health. They are very common in children and young people, especially in those who are poorly developed and poorly nourished. They serve no useful purpose, and, while they sometimes disappear in adult life, it is not usually wise to take that risk. They should be removed in early life. The tonsils are two small bodies of soft tissue, one at either side of the entrance to the throat, and normally are about the size and shape of a small peanut. Unfortunately, in children with a tendency to catarrh, they often grow to two or three times their proper size, interfere with the breathing, and when associated with adenoids, are often the source of serious disease. They often become inflamed, producing tonsilitis or quinsy, and the inflammation sometimes spreads to the tissues of the neck. Abscesses form in them, and in some children they are a constant source of trouble. When they are thus diseased, it is wise and proper to remove them.

TUBERCULOSIS.

This terrible disease is of very frequent occurrence in children of all ages. It may appear in the form of general tuberculosis, or marasmus, with wasting and emaciation of the body; it may occur as a continued fever, and be mistaken for typhoid; it may attack the lungs in the form of a rapidly fatal broncho-pneumonia, or in a chronic form, with symptoms resembling those of consumption of the lungs in adults.

In the brain it appears in the form of tubercular meningitis; in the lymphatic glands it presents the appearance commonly known as scrofula; in the intestines it takes the form of tubercular peritonitis; and in the joints it produces distressing disease in the hip, knee, ankle, wrist, etc. It is one of the diseases in which heredity plays an important part; and children who are brought up in dark, damp, and otherwise unhealthful homes, are especially susceptible to it.

The treatment, to be of value, must be begun early. The child's surroundings must be changed; he must have sunlight and fresh air, good food, cod-liver oil, iron, and creasote. The many hospitals and sanitariums that have been established for children are doing a noble work in treating this disease in its various forms.

TYPHOID FEVER.

Typhoid fever is seldom seen under the age of two years, and is far less common in children than in adults. Its course is similar to that in adults, but it is usually less severe, less likely to have relapses, and is rarely fatal. It attacks certain glands in the small intestine, which become ulcerated or sore; poisons are reabsorbed from these sores, and produce the train of well known symptoms.

There is no specific medicine for this disease; the symptoms are to be treated as they arise. Cool baths must be given daily, the food must be liquid, and the strength be sustained until the poison of the disease is exhausted. It usually lasts from six weeks to two months.

WETTING OF THE BED.

Enuresis is the term physicians give to this unfortunate habit. It is common in both boys and girls under five years of age.

When the urine is unusually acid, as in children who have a tendency to rheumatism, St. Vitus' dance and other nervous diseases, it is of common occurrence. Children who have bladder disease, or pinworms, boys who have not been circumcised, children who are careless and neglectful in emptying the bladder, are subject to it. It is usually a simple matter to correct it. See that the child empties the bladder and bowels before going to bed; give only a light supper; circumcise the boy, or otherwise remove the cause when it can be discovered. Medicines will seldom be required; belladonna is sometimes given, but it is a dangerous drug, and must not be used without medical advice.

WHOOPING COUGH.

This is a highly contagious disease, in which there is catarrh of the mucous membrane, and a peculiar and very irritating cough. It usually begins with a cold, which lasts a week or longer, and is followed by the spasmodic or coughing stage lasting for a month or more, when it finally subsides. The paroxysms of coughing may be few, or they may be almost continuous. The cough is metallic, and may end in vomiting, in gasping for breath, or in the discharge from the mouth of a plug of mucus. The disease sometimes results in broncho-pneumonia.

The symptoms begin one or two weeks after exposure to the germs of the disease. Treatment is often ineffectual, and the disease wears itself out gradually.

A change in climate, especially to the seashore, is often beneficial, and, in any case, an abundance of fresh air and sunlight is always desirable. Inhalations of steam from a croup-kettle are often helpful, and in the water of the croup-kettle may be dissolved a teaspoonful of creasote or of benzoic acid, or the same quantity of syrup of ipecac. Even when the symptoms are mild, the child must not be neglected, for a mild case can easily develop into a very severe one.

CHAPTER XXXI.

Hints and Suggestions Concerning Home Care and Nursing in the Diseases of Early Life.

MANY of the ailments of childhood are simple and uncomplicated. If you watch a young animal you will observe, when he is fairly well developed and has plenty of food and sleep, that only rarely is there any evidence that he is sick. If he is sick, he usually goes into a corner by himself, curls himself up, declines food, and sleeps a long time, presumably until he feels better.

Occasionally animals are seen eating certain herbs that are known to have a medicinal action, the teaching of nature, therefore, being that certain medicines are occasionally necessary and useful.

But man has neglected or endeavored to improve upon the simple teaching of nature in caring for the sick, and has invented innumerable remedies for almost every ill that flesh is heir to. Most of these medicines are useless; many of them are positively harmful; a few are indispensable. We could not very well do without opium for the relief of pain, and quinine for malaria.

No development in connection with the care of the sick has been of greater importance than that of the art of nursing. A good nurse is a physician's right hand. She shares his responsibilities, takes his place in his absence, and is always at hand to note changes in the patient's condition. It is equally true that a bad nurse, a gossiping nurse, or one who is unfaithful or disloyal, is an unmitigated nuisance and a menace to life.

As there are many ailments which do not call for medicines—at least patients get well without them—so there are many ailments which do not require a physician or even a trained hospital nurse. Both the physician and the trained nurse are luxuries that can not be afforded in many a household, though it is true that there are very few physicians whose services are not available for cases of charity. It must, therefore, fall to the lot of the mother, or some other member of the household to care for sick children, especially if the sickness is not of a serious nature.

A CHEERFUL ROOM.

The first essential in caring for the sick is a bright, cheerful room. There are very few diseases in which sunlight is not desirable as a means of assisting recovery. It destroys many varieties of germs, and is almost invariably more agreeable to a sick person than gloom or cloudiness.

It is equally important that a sick-room should be well ventilated, that bad odors should be carried away, and that the air be kept constantly in motion.

Only such furniture as is absolutely essential should be in a sick-room—pictures, curtains, even carpets being unnecessary. Cleanliness is all-important, and this can be attained much better with bare floors and walls than with an abundance of furnishings. The sick room should always be supplied with plenty of water and towels, and the hands and face of attendants should be frequently washed. Bed-clothing should be removed as soon as it becomes the least soiled.

If a sick-room can not meet these requirements, except in very slight ailments in which the patient is in bed only a few days, it would be far better to remove him to a hospital, if possible. In many cases, especially in the country, it will be well to have the patient in a tent, using that as the sick-room. Experience has shown that no better room for this purpose can be had.

It would seem hardly necessary to say that a sick person should have a room to himself, only the nurse sharing it with him. It is even preferable that the nurse should occupy an adjoining room, when this is possible.

VISITORS.

Sick persons are often the victims of attentions on the part of friends who mean to be kindly, but are really harmful. It happens frequently that a patient who was quiet and restful becomes excited and fatigued after a visit from one or more friends. It is, therefore, extremely important to limit the visits of friends to a very small number, and for very brief periods. Moreover, great care must be taken in the selection of the friends who may visit the sick, the visits of others being gently but firmly declined. Quiet and rest are necessary aids to recovery from disease.

The limitation of the visits of friends may prove a hardship, especially among the poor and ignorant, who frequently come in crowds to the sick-room, probably with the mistaken notion that they are doing a kindness. These precautions are doubly important in the presence of infectious and contagious diseases. It is an easily demonstrated fact that many such diseases are transmitted from sick rooms by persons who have been there from motives of friendship.

CLEANLINESS.

Not only should the patient's bedclothing and room be always clean, but the patient and the nurse must be equally so. The conditions of severe illness are such that it may be at times impossible for the nurse to take a daily bath, or to change her clothing as often as is desirable; but, with this exception, such a rule should be observed, and, when it can be done, much will be added both to the comfort and efficiency of the nurse. The patient should be bathed daily, one portion of the body at a time being exposed, sponged with warm water, dried, sponged with alcohol and water, and again dried. Of course there are occasions when this rule also can not be rigidly adhered to, especially when the patient is very feeble, or the disease very serious, so that even the slightest disturbance may have an unfavorable effect.

INFLUENCE OF NURSING ON SLEEP.

Sleep being the great essential during sickness, the aim of the nurse, or attendant, should be to induce sleep by all the means at her command. There should be no loud talking or disputing in the sick-room, no noise from heavy or squeaking shoes; quiet should always be maintained. This injunction means much to those who are very sick, and who are so sensitive that even the weight of the bedclothes, or the ticking of the clock, will annoy them. The mere presence of the nurse often has much to do with the patient's sleep and rest. Some women will antagonize a sick child, and it is best not to force an uncongenial person upon the patient, for the object of nursing is to assist the patient in getting well; and sick children can seldom be reasoned with or persuaded that the nurse whom they dislike may be the best they could possibly have.

On the other hand, there are women who always bring a soothing influence, and sunshine to the patient, the moment they enter the room. Such women are indeed a great power for good, for, if it is possible to charm away disease and induce the patient to rest and sleep, they will do it.

FOOD.

In feeding the sick, it must be remembered that the digestive apparatus is not in condition to dispose of food as it does in health. There is not only lack of appetite, but the digestive juices are deficient in quantity and in quality. The food should, therefore, be of the simplest character, as concentrated as possible, and either liquid or so soft as to enable the patient to dispense with the effort of chewing. Milk, either hot or cold, and fermented or predigested, is the ideal food for the sick, if there are no objections to it on the part of the patient. Beef tea, which is so commonly used, has little nutrient value, but it is stimulating and has a favorable action on the kidneys, especially when taken hot. Veal, mutton, and chicken broths, gruels, gelatine, white of egg, milk-toast, ice-cream, and fruit juices are usually agreeable, and the diet can be varied by choosing from them. The ordinary food of the table is not suitable for the sick.

Sick people should be fed at short intervals; the quantity of food allowed should be small, but increased according to the condition of the patient.

IMPATIENCE WITH THE SICK.

It is not to be expected that sick children will have the same sweetness of disposition they may have when in health. They are very often cross, impatient, and unreasonable. Those who undertake to nurse them must always bear this in mind, and not meet impatience and anger with impatience. Herein is the evidence of ability in nursing. As well should a mother lose her temper with a crying baby, as a nurse with a fretful patient. Gentleness, forbearance, and constant effort to soothe and comfort the sick, are powerful factors in bringing about convalescence and recovery.

CHAPTER XXXII.

Influence of Health and Disease Upon the Disposition and Temper.

ONE of the most important duties of parents and teachers, and one that is greatly neglected, is the training of the disposition of the children under their care. What do we mean by the disposition or temper of a child? We mean his habitual or ordinary conduct, particularly with regard to the passions or affections; in other words, it is the character of the child. Animals as well as young children have a disposition, and if healthy, they begin to play as soon as they are old enough to run about. Puppies show their happiness by taking things in their mouths and running away with them, shaking them and tearing them to pieces. In the same way a child a year and a half or two years old shows its happiness by running about and making noise, and breaking things. They are both happy in their ignorance; but they can easily be trained to direct their energies into useful channels. The baby can be taught to bring its mother's slippers, just as a certain little black spaniel named Mike, when only a year old, was taught to go down three flights of stairs every morning and bring his master a bottle of mineral water, which the cook put in his little basket, and which he then carried upstairs in his mouth. Next to keeping in constant motion, a child wants most to find things out for itself. This desire should be encouraged, and as far as possible, its questions should be answered. When the child is two years old some one may give it a package of candy. By being allowed to eat it all itself the first time and a few succeeding times it would grow up with a selfish disposition; but if the mother persuades it to give most of the candy away to others, keeping only a small portion for itself, and praises it for doing what at first it was compelled to do, it will in a short time develop a generous disposition, in order to receive praise. In due time it will become generous without praise, because it will discover that it can derive much greater happiness from being generous than from eating the candy itself. "I taught my little dog to carry my bag down the street," said Mike's master, "at first by compulsion and rewards, until he developed the habit, and then he became anxious to carry it of his own accord in order to get the encouragement I always gave him. Mike has a loving disposition, which has been cultivated by the love with which he had been surrounded, and now he has hundreds of friends who love him. If any one were to accuse him of biting a child, his friends would go into court and swear that the thing was impossible. His character and loving disposition are so well known that it would be hard to convict him. Mike is ten years old now, and this summer we got a fox hound puppy named 'Grasper,' who tormented him almost beyond endurance; yet he never lost his temper, but took the greatest care never to bite or hurt the puppy."

DOES A CHILD INHERIT ITS DISPOSITION ?

If this question had been asked twenty-five years ago we would have answered, "Most certainly, yes." But great discoveries have been made since then, the most important being that many things which we used to think were hereditary we now know to be acquired. We know now that a child, when its father and mother are both dying from consumption, can often be saved from the disease if it be immediately taken to the country to a house where no consumption has ever been. Such an experiment has actually been made in France. There are thousands of poor consumptives every year taken care of by the "Assistance Publique'' in Paris. There the city not only brings these poor people to die in comfort in the hospitals, but it relieves their terrible anxiety about their children by taking the latter to an establishment in the country especially devoted to orphans whose parents have died of consumption. A gentleman who has suffered torture from gout for many years claims that it is entirely due to heredity. But if we inquire into his mode of life we find that he alone is to blame, and that any one who eats three dinners a day, and sometimes four, and who drinks whole bottles of acid port wine at a time, as his father did, and as he does, without taking any exercise, would just as surely acquire gout as these gentlemen did. There are countless instances to show that heredity is often made a scapegoat for our ills when the real trouble should be credited to example. Does the father habitually use bad language in the presence of his children? Is he slovenly in his dress and careless as to his personal cleanliness? Do both father and mother spend every meal hour in saying unkind things to each other, and quarreling? Then will the children grow up with similar bad habits; not because they are inherited, but purely and simply from imitation. ''As the old cock crows the young one learns,'' and ''The young one is a chip of the old block'' are two very old and true sayings. Parents can not be too careful of their behavior before their young children, for they may be sure that not a word or gesture is lost upon them. If the father always addresses the mother with some term of endearment; if the children see both father and mother vieing with each other in making sacrifices for each other; then will the children be gentle and loving and unselfish. If the little children hear their father telling their mother every day when he comes home to dinner how he cheated one man out of fifty dollars, or made a hundred out of some one else by sharp practise, how can they be expected to grow up anything else but liars and cheats?

A mistake which many people make is to think that you must not begin to train a child until it is four or five years old. The training of a child should begin when it is only a few months old.

A mother once asked a clergyman when she should begin the education of her child, then four years old. He replied, "Madam, if you have not begun already, you have lost four years. From the first smile that gleams upon an infant's cheek your opportunity begins." Let me give you a leaf out of my own experience. When I was three years old attending a kindergarten I deliberately yelled for nearly an hour in order to subdue the kind-hearted teacher. Fifty times during that hour she could have subdued me by a quick spanking. When my own little boy was three months old, he tried to subdue his gentle little mother by screaming. I took him into a room with me, and locked the door. In five minutes he stopped yelling, and began to cry, soon after which he fell asleep. This little lesson, repeated three or four times at intervals of a week, made him one of the best of babies. The mother should be the queen of the home, and the father should lose no opportunity to impress this upon the children.

A mother of a large family once consulted me about her health, and I found that she was not digesting her food. On inquiring as to when and how she had her meals, she told me that she had not had a regular meal for many years. When her children returned from school, and later when they came from business, she had the meals all ready on the table, but instead of sitting down at the head of her table, as a Queen should do, she was ordered sharply about for the next hour, running upstairs to get a handkerchief for one, and down to the cellar for a cold drink for another, besides waiting on them all at table. When I told her she should be sitting at the head of the table while the children took turns in waiting on her, "The Queen of the Home,'' she burst into tears, and replied that she felt sure that they would put her out in the street when she was no longer able to be their slave. Now, who was to blame for such cruel, selfish treatment of the mother? Certainly not the children; for they were only doing what they were trained to do. The mother alone was to blame for their selfish disposition. And yet she meant well.

So convinced am I that a child is largely what its environment makes it, that I believe that if the Archbishop of Canterbury were to adopt a year-old child, both of whose parents had died after living a life of crime, that child, if constantly with that good man, would surely grow up to be a good and worthy citizen of his country. Of course, there are exceptions to every rule, but these exceptions prove nothing. The general fact is true. If a child is properly fed and brought up in the fresh air and sunlight and is properly trained it has every chance of having an attractive disposition. But what about a child which has been brought up under such bad surroundings that it has a bad disposition? Can it be made better? To some extent it may. But as we have already said, whatever a child is during its earliest years, it is very apt to be all its life. It is only by the most patient and persevering efforts that a bad disposition can be trained out of it. Children if healthy have strong wills. This is a good thing in a way because it means that they will be leaders of men. But these children are trained with great difficulty in order that their valuable energy and will power may be directed to good and useful channels. But the more *troublesome* a child is the more *care* and *patience* should be exercised by the parent or teacher.''

EFFECT OF DISEASE ON THE DISPOSITION.

A normal, healthy baby if placed in proper surroundings and given the right quantity of suitable food will usually have a happy disposition. It will sleep most of the time and when awake will take exercise by kicking its feet, and striking out with its hands. But the healthiest baby in the world will cry if tortured inside or out. But who would torture a baby? No one willingly; but all the same many babies are tortured. A baby that is fed too often and too much is tortured by the decomposing food until it screams with pain. Nine times out of ten some one will say that it is starving, and it will be fed again perhaps only half an hour after its last meal. Or on a hot day, when thousands are sitting at the front door in their cotton suits, trying to get a breath of air, where is the baby? Wrapped up in a flannel shirt, a flannel vest, a flannel coat, and a woolen overcoat, it is lying in a cot or baby carriage with a cover over it, in a hot room without a breath of air. This may seem an exaggeration but it is not; it is due to the mother's inordinate fear that the baby may catch cold. The perspiration is pouring out, and it is parched with thirst. Its sufferings make it cry for mercy, but it is misunderstood. It gets another drink of milk, and is then wrapped up again more closely than before. The agonizing colic, due to the decomposing milk, compels it to continue its crying which is the only means it has of expressing its feelings, but no one shows it any pity. How can its sufferings be relieved? Why simply by taking off some of its midwinter articles of clothing and putting on a cotton summer suit, and then putting it out in the air like anybody else. Instead of giving it liquid cheese for its thirst, give it some sterilized water to replace that which has been lost by the profuse perspiration. As soon as it gets rid of its physical suffering it will be happy again. If a child is not thirsty, nor over-fed, nor over-clothed, and not stifled for want of air and yet is fretting and irritable you may be sure that it is sick, and pretty sure it is in pain. When children are older it is easier to find out what is the matter, because then they can tell us whether they have pain or not; but sometimes they are restless and irritable without having any pain, and in fact they do not know themselves what is the matter with them. The three commonest causes are tea and coffee; indigestion; and irregular meals. A child who eats a fourth meal at night will have no appetite for breakfast next morning. But about ten o'clock it will begin to feel hungry and a foolish mother will then give it a lunch which in turn will prevent it from eating a hearty regular dinner. In other words the stomach is never allowed to complete its work and get even a few minutes rest before the next meal, with the result that the food decomposes and gives off poisons which irritate the brain and nervous system. Such children have restless sleep and wake up tired. Give them cocoa instead of tea and coffee, give them only three regular meals a day and let them sleep in a cool, well-ventilated room, or out of doors, and they will awake rested and hungry.

Again, take older children, from three to ten years of age. Their disposition also will depend very largely upon their food. As we have seen, the disposition is the expression of the habitual action of the mind. The mind is situated in the brain, the brain is fed by the blood which is pumped into it by the heart, the two most important elements being phosphates and iron. Now candies and cakes contain nothing but sugar and fat and starch, so that a child who is fed on the most expensive of these articles will be starved as far as its brain is concerned. Besides the children of the rich are often allowed to stay in bed in a darkened room, in the morning, for several hours after the sun is up. They therefore lose the beneficial effects of the sunlight upon their blood cells and become anæmic, which means that their blood is poor. When they try to use their brains at school, the poor children who have had much less and much cheaper, but far more suitable food, such as oatmeal porridge, common bread and vegetables and fish, all of which contain a great deal of phosphates and iron, excel them. If you look over the list of the great leaders of men in the United States and Canada, you will find that many of them were born either in Scotland, where children are fed two or three times a day on oatmeal, and once or twice a day on fish, or in the maritime provinces or states where they were brought up very plainly and simply and very largely on fish. They were all up and working when children at daylight, and were sound asleep at nine at night after saying their prayers at their mother's knee. No wonder that so many of our ancestors three hundred years ago were sun-worshipers; they owed all the physical and mental comfort they had to the light of the sun.

If you visit a menagerie or zoölogical garden you can almost classify the animals as to their diet, by the way they conduct themselves. The meat eaters, such as lions, tigers, leopards, jaguars, panthers, and wolves, are never still, angrily pacing up and down their cages all day. The plant-eating animals, such as deer, camels, giraffes, elephants, and rhinoceroses are calm and placid, mild of eye and gentle of manner. In a similar manner many children show by their disposition the diet they have received—those that get red meat three times a day being quarrelsome and ill mannered. A quarrelsome child may be rendered quite tractable by feeding it on vegetables and fruit, and especially on farinaceous food.

JUSTICE IN ALL OUR DEALINGS.

If we want a dog or a horse to have a good disposition we must invariably treat it not only kindly, but justly. When it does something wrong we must punish it, and when it does something good we must reward and praise it. A kindly treated dog becomes man's surest friend. Children are still more sensitive to praise and blame. ''When I was a little boy of eight,'' said a man who is a friend of children, ''I was entrusted with a difficult order by my father which I did my very best to carry out as I understood it. Instead of receiving the praise, which I thought I had earned, I was censured and my feelings were hurt. My parents noticed my sad appearance and thought I must be ill; but a British admiral, an old friend of my father, who was staying with us, said to them 'the boy is broken-hearted.' After an apology from my dear father and praise for what I had tried to do, I was soon all right again.''

The writer believes that a horse has a similar feeling when he is being beaten while hauling a heavy load up a steep hill. The city in which he lives is built on the side of a mountain, and during the months in which the people are laying in their winter's supply of coal many thousands of tons are hauled up the steep hills.

An old gentleman, who is by no means rich, noticing the struggles of the poor horses in hauling their heavy loads, and too often the cruelty of their drivers, paid to have a big strong horse and a kind-hearted boy at the foot of the hills to offer their help free to the poor coal-cart horses.

If boys and girls, and men and women for that matter, desire a happy disposition they must not think of their own pleasures, but how to make others happy. I know a little lad of seven who was sent by his father to see a play called the ''Message from Mars.'' The principal character in the play was the most selfish man in London, and the messenger from Mars was banished to the Earth for some crime he had committed, until he had converted the most selfish man on this planet from his selfishness. The whole moral of the play was ''Think of others.'' When the little lad came home he said he was going to lead a different life in future. And so he has, and now at the age of seventeen he has been chosen by his comrades president of the high school and captain of the football and hockey teams. He is loved by every one who knows him. He has been a faithful nurse for several years to a helpless sick brother, and he is a striking instance of how a little thing may turn the whole current of one's life and disposition, and of how happy and contented we may become in proportion as we live for the good of others.

SICKNESS SOMETIMES DEVELOPS THE LOVABLE AND ATTRACTIVE SIDE OF THE DISPOSITION.

A boy of fourteen was thrown from his bicycle by another boy, and developed hip joint disease. He was a year in bed with an extension weight, and for a year more was obliged to wear a steel splint in order to be able to walk. During these two years he received only love and kindness and any rough companions who might have injured him in his weak condition were kept away from him. As he could not play at all, his time was occupied with reading and music, and in receiving the visits of kind and gentle people who were moved with pity for his misfortune. During the two following summers which he spent in the country, he was out night and day, on a broad, beautiful lawn. When he recovered from this sickness he was elected president of the high school containing more than six hundred boys, and the following year, at the university, he was elected president of his class. Then the disease broke out in the other hip, and for two years he has been quite helpless. During this time he has read many books which he would not have had time to read if he had been well, and his suffering has made his disposition so gentle and refined that now, at the age of twenty, he is the most popular young man in a large social circle. His surroundings have also greatly influenced the conditions of his sickness. The sun and fresh air, and plain but nourishing food for his body, and the good books and loving friends for his mind, have not only turned the balance in his favor, so that he will recover eventually, but they have improved his disposition; while had he lived in a dark and crowded city tenement with bad food and worse language he would have been dead long since. Did space permit we could tell you of many of the world's greatest men who owed their greatness to some sickness which developed their character.

DULLNESS AND STUPIDITY IN CHILDREN.

There are many cases in which children are dull and stupid because they have been poisoned. Stone jars are glazed with lead; and pickles kept in such jars have caused many cases of lead poisoning, which causes constipation, colic, and a blue line around the gums. Children who have been poisoned by eating such food are dull and pale. Other children may be dull and stupid as the result of disease of the kidneys following scarlet fever. The poison of consumption on the contrary causes hectic fever and renders a child unnaturally bright. Many other children suffer from adenoids, or growths in the nose and throat, which block up the inner entrance to the ear. This causes deafness, and if unrecognized, the child may be punished for inattention. The regular inspection of all school children, by an experienced physician, at least three or four times a year, often detects these cases and so prevents much injustice.

A great many children are stupid or cross because they have been poisoned by improper food, such as pies or cakes; or even by eating good food at improper times, between meals, or at night. Eight o'clock in the morning, at midday and six in the afternoon are the best times for most school children's meals. This allows them to go to bed at nine with digestion nearly completed. Any food which does not digest within two or three hours may decompose and become poisonous; and poisonous food invariably affects the disposition unfavorably.

MAY A CHILD'S DISPOSITION BE CHANGED?

In a former paragraph it was pointed out that a child's disposition or character was not an inheritance so much as an imitation, and was consequently pretty much what its surroundings made it. If a child spends most of its first ten years in the company of its mother, and if she has a loving and gentle disposition, the child will copy her every thought and action, and people will say in a general way that it takes after its mother. If the mother dislikes children and has no time to spend on the sacred trust of bringing up a family, and leaves the care of her little ones to servants, the children will naturally acquire the disposition of the servants. In some cases this may be desirable, for the nurse girl may have a fine character, and, if fresh from the country and especially if from a Christian home, she may have the purity and freshness of the country atmosphere. But if she has come from the crowded slums of a city, there is great danger that the child's disposition will be seriously impaired. But you may ask, "Can nothing be done for a child that reaches ten years of age, or even fifteen, without ever having had a good example to imitate?" Yes; although it is difficult to change a child's disposition, after it has reached ten years, it can be done, slowly and laboriously, but none the less surely. In a great iron works they were making the shaft of an ocean liner. Out from the comparative darkness of a smoky shop a mass of white hot metal was brought from the glowing furnace by means of a pair of pincers, which only a giant might wield. But an army of apparent pigmies seized upon it, and by the aid of the proper mechanism, whirled it over to the forge, where some fifty feet of the great steel shaft were already made. Then another pigmy touched the handle of the great steam hammer, and rained blow after blow upon it. At first they seemed to have little effect, but after many hundreds of blows had been struck, not only was the great square ingot of steel welded firmly to the piece already made, but it was also becoming round and lengthened out. As the metal turned from white to yellow, it took ten strokes to do now what was accomplished by one blow when it was at a white and more plastic heat. Then, as it turned to cherry red, it required hundreds of blows to obtain such a result. At last the time came, as the steel began to set, when repeated blows produced no effect. But the task was accomplished. The rough, unshapely mass of steel had been molded to the required form.

How like the building of a child's character was the formation of that perfect shaft of steel! At white heat, it was like a piece of putty, plastic and easily molded. That corresponds to the first two or three years of a child's life. The blows of the hammer are the firm but kindly corrections of the mother, no single one of which produces much effect on the child; but when continued hour after hour, and day after day, they gradually build up a straight, but by no means finished character. If the workmen had waited until the steel had partly cooled, they could still, perhaps, have rounded the square block of metal, but with far greater effort. And so the child, who is allowed to remain uncorrected during its most plastic age, can still be brought into shape between three and five, but with how much greater trouble than if the work had been done between one and three. It is needless to say that when it comes to forming the character after it is set in the wrong way, the task is much more difficult although not impossible. At that stage the help of the child itself must be enlisted, sometimes by awakening the sense of honor, at others times the sense of duty, and at other times by religious belief.

A young person can do for himself or herself, starting from within, what its parents or guardians might have easily done from without, at the proper time. The best way is to take one's faults, one by one, and persistently hammer at them until they have disappeared. If your fault is quick temper, make up your mind never to speak or act upon hasty impulse, which might lead you to do something for which you would be sorry, all your life. But wait a minute, by the clock, for then your anger will have cooled. If you are selfish, write out the motto, ''Think of others,'' and keep it ever before you; and after a hundred kindly actions, performed almost unwillingly at first, the hundred-and-first will be quite easy. If you are indolent, don't dally with temptation to sit idle, and put off until tomorrow what you might do today; but the moment you feel it is your duty to do a thing, spring into action, and DO IT NOW.

Strength of character, like strength of body, comes with use. The blacksmith's right arm is the stronger with every blow which he strikes upon the anvil; while we become weaker with every moment of inactivity.

OPTIMISM AND PESSIMISM.

Most young people know the meaning of these two words. An optimist is one who takes the best possible view of everything, while the pessimist is the very opposite. Not only does the optimist see the best side of things as they really are now; but he has a firm belief that things are going to keep on getting better all the time in the future. The pessimist not only looks on the worst side of things as they are at present, but he discounts the badness of the future; he believes that bad as everything is now, it will keep on getting worse. The optimist is thankful for all his mercies; the pessimist is finding fault with them. Two men were going down the street one day during a gale of wind. A chimney pot was blown from its fastening, and struck them both on the head. Although the optimist was so badly hurt that he was unconscious for several minutes, his first words on recovering his senses were, ''Thank God I was not killed.'' But the pessimist who only had his hat dented in, and escaped without so much as a scratch, cursed his bad luck, as well as the gale, and the owner of the house. One of the greatest misfortunes which can befall your disposition is that it should become pessimistic, and one of the greatest joys and blessings is that it should become, and remain, optimistic. And this brings us to the important fact which is not generally recognized as it should be, that whether you are an optimist or a pessimist depends very much upon your liver. There is a Latin proverb: ''Mens sana in corpore sano,'' which means: ''To have a healthy mind you must have a healthy body.'' The liver is the organ charged with the duty of purifying the blood. As the blood is pumped through it, it has the wonderful power of secreting the bile. If bile remains in your blood, and accumulates in sufficient quantity, you become jaundiced, and then everything appears dark and cloudy to you, because you are looking, as it were through a layer of bile. Even your eyes as well as your brain are stained dark yellow by the poison. If the condition is not relieved by nature or the doctor's art within a few months, it will kill you. Let us hope that jaundice will never affect you or any of your friends, for no matter how bright they were before, their disposition will then be completely changed, and they will become pessimists. Sarah Bernhardt, the great French actress, once said, that the darkest disposition could be brightened by rhubarb. She was not far wrong; for this simple drug cleans out the poison from the stomach and liver, and so clears up the mind. Very often when children are sad and gloomy, a dose of some simple laxative will make them as joyful as ever.

There are certain forms of dyspepsia in which the food turns into a poison called oxalic acid. If the most cheerful person in the world bought a few cents worth of oxalic acid at the druggists, he could completely change a bright disposition into a gloomy one, by taking a small dose of it every day. Many people are manufacturing this drug in their own bodies, simply by taking too much meat, and not taking enough exercise. Pessimism is much more common among the city people, because they do not get enough fresh air or oxygen to burn up the food they eat, and it therefore fails to be assimilated. Besides, most city people go to their offices and factories in the morning, and remain there till late in the afternoon with very little sunlight. The strongest and healthiest man would become a pessimist if he were deprived of sunlight for a year. It is only within the last few years that the importance of air and sunlight has been fully understood. Doctors are saving hundreds of lives by teaching their patients to sleep in the open air at night, and to spend as many hours as possible in the open air every day. School teachers, too, are paying more attention to the ventilation of the school rooms, because they know that boys and girls can not be attentive and industrious when they are poisoned by bad air.

CHAPTER XXXIII.

Accidents: Their Causes and How to Avoid Them.

ACCIDENTS which happen to very little children who are too young to know of the danger, or not strong enough to avoid it, are often due to carelessness on the part of an elder person, brother or sister, or nurse or parent. The boy or girl who is left in charge of one of these little toddlers should foresee and prevent any possibility of accident. What a disgrace and sorrow it is when one's little brother falls upon the hot stove and has his face scarred for life, interfering with his business and pleasure to the day of his death. And, if possible, the result is even worse if it is a little sister whom one moment's carelessness on your part has disfigured or crippled for life.

A good many accidents which older persons avoid are common with boys and girls not so much because children are not so strong, but because they venture into more danger and are not so thoughtful to guard against it. Not one man out of a hundred ever climbs a tree, and when he does so he makes sure that the branch he trusts his weight upon is strong enough. All boys and girls climb trees presumably, and the broken collar-bones and arms show that they are not all careful to stay close to the trunk of the tree, or on large, strong branches.

Children playing ball or tag in the middle of the street will often run directly in front of an automobile. Of course they don't know it is there, but they should have sense enough to look before they leap.

It is a wise child that is able to take the advice of older people and does not feel that he must find out everything for himself. A dear old man in Central New York who used to whittle bow-guns or cross-bows for the boys, used also to tell the story of one boy who loaded the bow-gun and put the butt against the tip of his nose. "I told him it would kick him, but he said he didn't care." Of course the boy had a nose-bleed after he pulled the trigger.

The boy who gets his fingers cut off in a mowing machine, or in a machine for cutting up fodder for cattle, knows that it is dangerous to put his hand in the machine, and knows that if he has to do so he must take his hand away in time. This may happen a hundred times, and then if he thinks of something else for an instant his fingers are gone.

If you have got to do anything which is more or less dangerous to yourself or others, or even to furniture or other property, just think of that one thing until you are through with it.

DIRECTIONS FOR USING FIRE ARMS.

The fool with a gun that he did not know was loaded is almost always a boy. Don't let him point it at you or anybody else except perhaps himself. Don't have anything to do with a boy who can't learn to always hold firearms, whether supposed to be loaded or not, in such a position that no one can be hurt if they are accidently discharged. Guard against the trigger being pulled in dragging a gun over a fence or across the seat of a boat. Hold the gun clear of the obstacle and with the muzzle pointed to the sky. When you are out hunting don't shoot at an object that you see indistinctly. Every season several boys are killed by their companions who mistook their cap or coat for some wild animal.

A pistol loaded with blank cartridges should be handled just as carefully as if loaded with bullets. The one to be hurt is usually the owner, and the charge enters the palm of his left hand, making a ragged looking black wound. Half an inch deep in the flesh are embedded the burnt wads, powder, charred bits of skin, and any disease germs that happened to be upon the hands. The germs of tetanus or lock-jaw are very common, and if some of these are carried into the wound the boy is then and there inoculated with a disease which used to be almost invariably fatal. These accidents used to make the Fourth of July a season of mourning in almost a thousand of our homes every year. The discovery of tetanus antitoxin has made it possible to prevent lock-jaw if used promptly after such an injury. The best way is to learn never to point a pistol where it can do harm if it goes off.

Powder grains sometimes lodge in a boy's face or hands from fire-crackers or toy cannons. They are like red-hot pieces of coal and are driven into the skin so deep that no amount of scrubbing will remove them. They are not of a nature to be gradually absorbed by the blood vessels and disappear like an ordinary black and blue mark; but on the contrary, they leave an indelible stain. Each powder grain must, therefore, be removed by the doctor. Sometimes the boy will ask the doctor to leave a single grain to remember the accident by. Powder grains sometimes put out a person's eyes. The possibility of having to go through life led by the hand should make a boy remember to keep away from the front of a cannon even if he does not expect it to go off. If the cannon fails to go off when it should, don't go and look into the mouth of it. That is the way many people have been hurt.

There are enough accidents which are not the boy's fault, to keep the doctors busy. The healthful sports which are necessary to growing boys and girls involve a certain number of injuries which do not begin to off-set the benefit from these sports. It is better for a thousand boys and girls to skate and coast even at the cost of a certain number of broken bones, than to sit in the house all winter playing checkers or reading books. It is better in the end even for the few who get hurt. Rough and dangerous games like foot-ball and polo are all right for those who have no one dependent upon them, and who take pleasure in measuring their physical strength and skill with others. They are not necessary, however, to the development of manly and courageous boys.

DANGER IN GASOLINE.

Burns and scalds often occur because the person does not know the danger. Many a girl has been terribly burnt while cleaning gloves with gasoline near a light or fire. The boy who pours kerosene on the wood when he is starting a fire runs a risk of being burnt himself, in addition to the risk of his father's losing every cent of insurance money in case the house is burned down. A scald from hot water is generally not so bad as one from hot oil or melted fat. The less severe scalds raise a blister over the whole scalded surface, and are painful for a few hours or a few days, but may not leave any scar. Scalds from boiling fat, however, usually destroy some of the skin, take a long time to heal, and leave a permanent scar. The difference is because boiling water has a temperature of only 212 degrees while boiling oil is very much hotter. Burns from touching red hot metal almost always leave a scar and if the scar is a large one it has a tendency to contract. A burn of the face and neck may cause the neck to be drawn all out of shape, disfiguring the person badly; and a burn of the hand may draw the fingers right into the palm of the hand and interfere with one's work.

BE CAUTIOUS WHEN PLAYING GAMES.

Broken bones often happen from falls and also from wrestling and other games of strength. If a boy falls out of a tree or from a horse, nothing that he could do on the way to the ground will make much difference in the result. If he lands on one shoulder his collar bone will be broken, or if he strikes on his elbow in a certain position his shoulder will be dislocated. He may land in such a way that no harm is done or he may have his neck broken and be killed. It is different, however, with falls received while skating or while walking upon a slippery pavement. Most of the broken bones and dislocated joints in this case come from instinctively putting out one's hand to break the force of the fall. This is a very great mistake. Standing on the ground it is almost impossible to get hurt if you can let yourself go all in a heap. But if you let your whole weight fall heavily upon one wrist, the bone is almost certain to break.

The doctor will tell you that a simple fracture, or one in which the skin is unbroken, is much less dangerous than a compound fracture in which the sharp ends of the broken bones have pierced the flesh and may have become infected with disease germs present on the surface of the skin or on the clothes. A greenstick fracture is possible in young people because their bones contain less mineral matter and are less brittle than older people's. It means that the bone has been bent and partly broken like a stick instead of breaking into two separate pieces the way that glass breaks.

ACCIDENTS FROM CRANKING AUTOMOBILES.

The most common is a fracture near the wrist and another is a dislocation of the shoulder. These and other accidents may be almost surely prevented by knowledge and carefulness. They happen when the engine back-fires and the crank flies back. When you get a blow from a steel crank with sixty horse-power behind it you are sorry that you did not take a little more time and do it right.

An automobile which is in good order back-fires because the spark is advanced and the explosion drives the engine backward instead of forward. This can be prevented by retarding or slowing the spark, and you should take a look at the spark lever the last thing before cranking. You are very foolish ever to crank a strange machine on which you do not know how the spark-lever should be set to retard the spark. Always pull the crank up from the bottom. Then if a back-fire occurs the crank may harmlessly be pulled out of your hand, whereas if you were pushing down on it a fly back would break your arm or dislocate your shoulder. Spinning the crank, or turning it quickly over and over, is dangerous because if a back-fire occurs it may come while you are pushing down on the crank.

Joints are sprained from being bent or straightened or twisted further than is natural. Two pieces of wood fastened together by a hinge can be freely bent or straightened a certain distance each way, but when you force them any further something has to give way. Either the hinge will be bent and twisted or the screws will be pulled loose or the wood will break. The ligaments of a joint correspond to the hinge and when they are overstretched or torn it causes a great deal of pain, swelling, redness, and stiffness; this requires medical treatment. The X-ray enables the surgeon to see whether the bones have been broken and it has been found that a good many cases, especially about the wrist, which seem like sprains, are really fractures.

Dislocations do not happen in exactly the same way. They do not always require as much force, but only that it shall be applied to one end of a long bone in such a way that the bone acts as a lever or crow-bar to pry the other end of the bone out of its socket.

There is danger of producing a sprain, dislocation, or fracture from twisting a boy's arm which is held behind his back or in some other position which makes him helpless; the right kind of a boy will not try tricks like this upon his playmates or upon smaller boys. It may be fun to hear the other boy beg for mercy, but he should remember that a very little too much force will produce a serious injury.

The Japanese method of self-defense known as Jiu Jitsu is a practical application of this principle and one part of it consists in grabbing the man attacking you by the hand and quickly twisting his arm into such a position that he has to give in or have his arm broken or dislocated. You remember the statement made by Archimedes, who lived hundreds of years ago, that if he had a fulcrum strong enough and a long enough lever he could move the world. In the same way a little Jap could break a prize-fighter's arm and put him out of business if he once got the right kind of a hold. What the prize-fighter would do to the Jap is another matter.

DANGERS THAT ATTEND SWIMMING.

Drowning is an accident which could nearly always be prevented. Even when a boat is upset you can usually get hold of something which will keep you afloat until help comes. No matter how good a swimmer you are, it is ever so much better to stick to the boat than to try to swim ashore. It may be much further than it looks; and with all your clothes and shoes on, you will find it a very different matter from swimming such a distance in a bathing suit. Then, of course, you might be taken with cramp. You are running a risk by leaving the boat while you are certainly all right if you stick to it. It is almost always the good swimmers who are drowned. They are often foolish enough to swim a long distance straight out from shore; then if they become tired out sooner than they expected, or if they are seized by a cramp, or if the current carries them away, they can not reach shore and are drowned before help can get to them. The good swimmer can swim as long and as far as he wishes, going back and forth along the shore. One of the most beautiful things in the world is to see a couple of Airedale terriers swimming near the end of a dock and chasing pieces of wood thrown to them. They will sometimes swim for half or three-quarters of an hour without resting upon the ground or any part of of the dock. Their owner need not worry about their safety. It was a different matter, however, when a pack of hounds started to swim straight out into Shinnecock Bay after a fox. Then the hunters had to scurry around to find boats and before the dogs could be reached, some of them had become exhausted and had drowned.

A professional swimmer always has a boat follow him on long distance swims.

A cramp seems to be more likely to occur in swimming than in any other kind of exercise. It may attack one leg and then the muscles of the calf become as hard as iron and so painful that the person is helpless. You are lucky if you are near land, as the writer once was, and can get ashore and have the leg rubbed until the muscle relaxes. The under-tow is something to look out for in surf bathing. Each wave carries a lot of the top layer of water up to the beach, and as this water runs back again into the ocean it forms an under current running away from the shore, and sometimes to one side as well. In some places and at certain times, the under-tow is exceedingly dangerous even for strong swimmers. It may carry them directly away from shore, or along the shore so far that they can not get back to a place of safety.

Boys and girls should never go into the surf unless there is a life-saver in attendance; and they should be particular to take his advice about not going in at all if the surf is dangerous, and about the distance that they should swim. He is usually a powerful swimmer and is provided with life preservers and a life-boat. Don't go into deep water unless you know how to swim pretty well. There is danger in the old idea that you can throw a boy into deep water and tell him to sink or swim. Ninety-nine times out of a hundred he will sink, and will be very lucky if he does not drown. Learn to swim just as soon as you possibly can. No other exercise in the world is so good for every organ in the body, and you can never tell when some foolish person will rock the boat or try to change seats, and upset the boat in that way. Since the war with Spain and the establishment of the naval station at Guantanamo, the warm sea water there has given an opportunity for compulsory education of the seamen in swimming; and now seven out of ten of the men in the United States navy can swim. Formerly only one or two in every ten could do so. Admiral Stevens (U. S. N. retired), who, as Captain Stevens commanded one of the ships at the battle of Manilla Bay, says that a great many lives are lost at summer resorts because so few people know how to treat drowned persons and bring them to life again. He gave his sailors lessons in the resuscitation of the apparently drowned and once had a chance to demonstrate it on a pet squirrel that fell overboard. He had all hands piped on deck and in ten or fifteen minutes the squirrel came to life, bit a piece out of the captain's finger, and scampered away.

Young animals and birds are liable to accidents just like boys and girls. Birds fall out of the nest and may be injured or killed, but very often might be saved if there were someone at hand to put them safely back in their warm nest. The poor featherless little creatures more often die of exposure than from the direct result of the fall. We know a boy who used to set broken legs for his chickens, and to keep them in splints until they had knit together. Puppies flounder around at first, and get many a fall, but as their adventures are all upon the surface of the ground, they do not get hurt. By the time a kitten is strong enough to climb a tree it has learned to hold on and cry for help if it so high that it can not get down. Cats always insist upon coming down head first and so have to run down. They would be all right if they came down backward because then they could hold on with their claws and come down as slowly as they wished to. If a cat gets up into a tree whose lowest branch is so far from the ground that he feels that he can not run down along the trunk head first without getting hurt, then he has to stay until someone climbs up and takes him down.

CARE OF THE NOSE AND THROAT.

Nose-bleed often happens from a fall or a blow on the nose and scarcely ever does any harm, and sometimes is even a good thing if the person is too full-blooded. When it comes as a result of picking the nose, the bleeding does not do any special harm. But picking the nose is a disgusting habit which grows on one and should be broken up as soon as it is discovered. If dry masses form in the nose they may be softened by putting a little cold cream in the nostrils at night, and then removing it by blowing the nose in a pocket handkerchief several times a day. After being out in the dust or on a railroad train, snuffing up water and allowing it all to run out of the nostrils, and then gently blowing the nose is an excellent thing for persons who have a tendency to pick the nose.

A broken nose sometimes happens from a fall, but more often from a blow or a kick, as in playing baseball or football. It is so apt to leave a deformity that a baseball catcher should always wear a mask, and all football players a nose guard. The nose may also be broken in a fight. The injury is not a dangerous one and would get well of its own accord but a deformity would remain; so it is always better to have it properly set.

More or less serious trouble often comes from putting things into the mouth which are not intended to be eaten but which are accidently swallowed. Coins often pass through the stomach and bowels without any trouble and so do the pits and seeds of fruit, but sometimes they lodge in some narrow part and may have to be located with the X-ray and operated on by the surgeon. An X-ray picture or radiograph had to be made of a child who was playing a game of grab, and popped a nickel or five-cent piece into its mouth. Before the father could turn the child upside down the coin had been swallowed. It lodged in the œsophagus, or food pipe, that leads down from the mouth to the stomach, and for nine days the child was unable to swallow anything.

Fish bones and chicken bones should not be swallowed because of the danger of their getting caught in the throat and choking the person. For the same reason it is dangerous to hold pins and buttons in the mouth. One young lady had an obstinate cough for two years, and finally coughed up a pin which was all black and had evidently been caught in the throat all that time. It is perfectly terrible to get any solid substance like a small cork, into the lungs or bronchi. It starts severe coughing and choking, and unless removed by the surgeon may cause death from suffocation, or from abscess of the lung. One can not be too careful not to suck any solid substance into the lungs with the breath.

A shoe-button or a pea put into the nose or ear requires the services of a surgeon to remove it; and even then is a difficult and painful matter. Unnatural substances put into the private openings of the body are equally dangerous.

No boy ever grew up without having cut his fingers in whittling, and while these cuts bleed and leave a scar, they are not dangerous except in the case of a child who is a "bleeder." Hemophylia is the name of a disease in which the blood does not clot in the opened blood vessels, and so stop the bleeding of a cut in a few minutes. Such a child may bleed to death from a cut which would not bother another child at all. In any ordinary case the only chance of serious harm is from blood poison from disease germs entering through the cut. Proper cleaning will prevent this. A cut from an axe may be more serious. It may open an artery and the bright red blood spurting out with a hissing noise means bleeding to death unless the flow is checked. What to do in such a case is told in the chapter on treatment.

CARELESSNESS CAUSES BRUISES AND CUTS.

Boys and girls who work about any kind of machinery must keep their eyes open and their minds upon their work every minute. An instant's inattention has often caused a heavy sewing-machine needle to go through a factory girl's finger passing through the nail and the bone and coming out on the under surface of the finger. Boys are apt to be engaged at heavier work and if their fingers are caught, they are mashed or torn in such a way that part of the finger has to be cut off in order that the finger may heal up.

A bruise happens when one is hit pretty hard by some blunt object. This may be sore for a few hours or a few days, but is not serious unless it affects something deeper than the ordinary flesh. For instance, a stone bruise sometimes happens from stepping barefoot on a small pebble. The periosteum or bone-skin of the under part of the heel becomes inflamed, and the boy can not rest his weight on the heel for a long time. Such an injury requires medical treatment. An ordinary black and blue mark is due to the bruising of the flesh, and breaking a number of the tiny blood vessels called capillaries. This escaped blood fills small spaces in the flesh just as a drop of ink fills the spaces in a piece of blotting paper. The blood gets almost black as it becomes stagnant and causes the black and blue appearance. After a while this blood is absorbed again and the mark disappears.

It is a different thing when a large blood vessel or artery has broken. Then quite a large lump forms, containing a lot of blood in a single cavity like water in a cup, instead of in a sponge. This is called a hematoma and may get well of itself; the blood first clotting, then becoming liquid again and being absorbed. This does not take place if it is a larger artery, because then the blood pressure is very great and surgical treatment is required. Even a small hematoma may become infected and the blood turn into matter, forming an abscess which the surgeon has to lance. All bruises may produce black and blue spots, but this is especially the case where there is a great deal of loose tissue. A bruise near the eye, therefore, usually causes a ''black eye'' which is not a dangerous thing but is usually regarded as more or less of a disgrace. It is thought to mean that the person has been fighting, which is a bad thing, and also that he has gotten the worst of it, or that he may have been drunk. The eye-ball lies in a socket where it can not be injured by any ordinary fall or blow. But of course it is liable to injury by any sharp-pointed object. The eye may be so badly injured that it has to be taken out; and people have even been killed by a sharp point passing through the eye and the thin layer of bone behind it into the brain. Fencing with a sharp-pointed umbrella would be a foolish and dangerous thing. A wire face-mask and a foil with a metal button on the end should always be used.

Cinders and bits of iron may get into the eye and cause itching, pain, redness, and watering from a flow of tears. The natural impulse is to rub the eye but this should never be done. It seldom removes the foreign body and often irritates the eye by scratching the cornea or central transparent part of the eye-ball which is very easily hurt. Rubbing the eye sometimes drives the foreign body into the eye-ball, or the inside of the eye-lid, like driving a tack into a piece of wood. This makes matters so much worse that the doctor has to be called, whereas ordinarily the patient or his friends can remove it. A serious accident may result from a bit of steel chipping off from a hammer and striking the eye. The piece of steel goes into the eye-ball just like a bullet and has to be located with the X-ray and removed by the surgeon who makes use of a powerful magnet. Simple means of removing ordinary foreign bodies from the eye are described in the chapter on treatment.

Kicks upon the private parts are very dangerous, and serious injuries may also be received from walking upon a narrow fence and falling astride it. A kick or a severe blow in the stomach causes shock or even death. The solar plexus and other important nerves are exposed to injury there, and the person becomes pale and cold, unconscious and almost pulseless. If the shock is not too severe, it may be recovered from without any special treatment; but it often requires medical attention.

BITES AND STINGS AND THEIR POISONS.

Bites and stings may be received from all sorts of insects. Bees and wasps will hardly ever sting unless they are attacked. But when a whole hive do get after a small boy it goes hard with him, unless some courageous woman throws her apron over him and drives off the bees. A very curious treatment, which some people are now taking for rheumatism, consists in allowing the patient to be stung by a certain number of bees every day. The poison in a bee's sting is chiefly formic acid which is good for rheumatism. The results of this method of treatment are yet uncertain. There is a very interesting fact about wasps and that is that the male wasps can not sting. They may be told by their white faces, and the writer has often caught and held them in his hand. Redbugs, or chiggers, are common in the Southern States. They are like a grain of red-pepper and would not be seen upon the skin unless you were looking closely for them. They burrow into the skin and raise a hard lump like a bird-shot. They are quite harmless unless the place is scratched and poisoned by the finger-nails. Ticks are much larger and must be removed by pulling, squeezing, or cutting them out.

The majority of snakes are entirely harmless to human beings. Those that are dangerous are of two kinds: snakes like the boa-constrictor which wind themselves around their victim and crush him before swallowing him whole; and snakes whose bite is poisonous. Snake venom is contained in a little sac in the roof of the mouth and is injected into the flesh as if with a hypodermic syringe, through the hollow fangs after the snake has struck. The poison fangs are the serpent's eye-teeth and have a sort of joint, so that except in striking, they are sometimes folded back in the roof of the mouth. The poison is gradually absorbed from the bitten place into the system, and the treatment applied in the first minute or two will have more to do than anything else with deciding whether the patient is to live or die. The rattle-snake has no desire to bite people, and if he sees them coming he gives them warning by his loud rattle. He only strikes when he feels that it is a matter of self defense. Some other snakes, like the water-mocassin, bite without warning and apparently for the mere pleasure of injuring people. It is a very important rule in places where snakes abound never to walk through swampy lands or among low bushes where you can not see your feet.

Dog bites are of two kinds. Those from a dog which is not mad require ordinary cleansing and surgical dressing. They are often very severe and painful, and a great deal can be done to avoid them. Don't try to stop a dog-fight by taking hold of the dogs. Even your own pet dog may bite your hand while he is trying to bite the other dog. Beating the dogs or pouring cold water over them are usually successful in stopping a fight. When a bull-dog has hold of another dog he is very unwilling to let go. Trying to pull the other dog away only gives him more pain, and the bull-dog does not mind an ordinary beating. The pail of cold water is usually the best thing. John S. Wise, who has written the best true stories about dogs, says that pinching the bull-dog's tail with forceps or biting it, will make him let go. When a bull-dog has taken hold of a man's leg, the best the man can generally do is to try to choke the dog. Don't put out your hand to strange dogs or try to take a bone away from a dog.

THE DANGER OF HYDROPHOBIA.

A dog is said to be mad when he has hydrophobia. This is a disease which always kills dogs or other animals infected with it. Hydrophobia makes the most gentle animal wild and savage, and ready to bite other animals or persons. A great many animals die every year of this disease and every one of them is capable of giving it to human beings by biting them. It is a disease which does not come of itself. It must be contracted from some animal which already has it; and dogs are the most frequent spreaders of the disease in civilized regions; while wolves and foxes carry it in wild regions. England has practically stamped out the disease by making all dogs wear muzzles unless they are held by a leash or cord; and by keeping dogs arriving from other countries, in quarantine, or not allowing them to land until the disease would have time to develop if they already have been infected with it. Some people do not believe in hydrophobia but think the patient is simply scared. These are people who have never seen a mad dog or pig dying after being bitten, or a child dying of it. It is not cruelty to animals to insist that no dog shall run loose in hot weather without a muzzle; and that stray, ownerless dogs which may be a source of danger to other animals or to people shall be caught and killed. When a person is bitten by a dog he should receive treatment prescribed in the next chapter and he should also, if possible, see that the dog is not killed, but is watched for some time for evidences of hydrophobia. If the dog has been killed it is absolutely necessary that its brain and spinal cord should be examined by an expert, to see whether it had hydrophobia.

Cat bites are usually harmless if cleaned and dressed surgically; and so are scratches. Taking a strange cat up in your arms is dangerous because it may scratch your eyes out in struggling to get away, or just out of ugliness.

A horse's bite is a cruel thing because the flesh is crushed, and some of it may die or slough away and leave a sore that will heal slowly and with a permanent scar. Any crush is much more painful than a tear or a cut.

SUNSTROKE AND FROSTBITES.

Sunstroke comes from over-exposure to heat combined, as a rule, with heavy lifting or other hard work or play. The worst cases produce a very high fever, a temperature of as much as one hundred and eleven degrees, loss of consciousness and death. The milder cases make the person feel weak and dizzy. He is unable to go on with his game of ball, or work in the hayfield, but is all right after a rest and the proper treatment. A boy or girl may faint away from too much hard exercise in the sun on a very hot day without its really being at all of the nature of a sunstroke. The more serious cases of sun-stroke scarcely ever happen to boys and girls because the circulation and all their forces are so much greater than in older people; because they have not weakened their powers of resistance by drinking whiskey, and because they do not have heavy work to do on the hottest days of the summer.

Frozen and frosted ears, noses, and toes are also less common in children than among grown-up people who are equally exposed. Children are more active and less easily affected. They must be on the watch, however, and take care of their ears, nose, and chin if they begin to get cold. A little rubbing once in a while or keeping the ears covered, will keep them warm and red. When a boy's ears or his nose turns white, or a white spot comes on his cheek it is time for him to stop everything else and try to rub the blood back into the parts which have turned white. This ought to be done before he goes into a warm place, for if not, the blood comes back too quickly and a sort of inflammation called frost-bite or chill-blain results. The toes may also be frost-bitten if care is not taken to keep the blood in them by stamping the feet when they begin to be pretty cold. If you come into the house with your toes very cold, don't sit down and warm them at the fire, that will cause chill-blains which will pain you every winter for years. Take off the shoes and rub the toes to bring the blood back into them and if it seems to be coming back too fast put the feet in cold water and continue the rubbing. Actually freezing any part is very much worse than a frost-bite. The frozen part becomes terribly inflamed, dies, and has to be cut off. This means weeks of suffering and sometimes many months before the feet heal.

INFECTIOUS DISEASES.

Many infectious diseases are more common among young people than among older people, because almost every one is exposed to them before he grows up, and one attack generally makes him immune; or leaves him so that he is not so apt to take it again. None of these diseases are of any benefit to the child, all are more or less dangerous, and some even if recovered from, are apt to leave a child permanently injured.

A disease is infectious when it is due to some germ getting into the system, and it is contagious when others are liable to get the disease from touching the patient or anything that he has touched. Some infectious diseases, like typhoid fever, are not contagious, and the patients are not liable to give them to their friends and attendants if proper means are taken to disinfect the passages from the bowels. Other infectious diseases are also extremely contagious so that people can catch them from being in the same room or even in the same car with them, or from using clothes or books which the sick person has touched. Measles and scarlet fever and whooping cough are among the contagious diseases from which few children escape, and which are difficult to stamp out without an absolute quarantine system of world-wide application which is impracticable at the present time. Although some children die of these diseases and others are left with deafness or some other life-long affliction, the great majority get well.

It is different with tuberculosis. This disease is so contagious that every case starts another, and is so fatal that it kills most people who have it. It is very difficult to cure but it is easy to prevent other people catching it if the patient and his friends are willing to take the trouble. What the patient spits up is full of the germs called tubercle bacilli, and if the spit dries on a handkerchief or upon the floor of a room or a car or even upon the street, the germs are carried in the air the same as any dust and may be breathed in by other people. This danger may be prevented either by the patient always spitting into a cup full of some powerful antiseptic solution, or into a piece of paper, or a paste-board cup which may be thrown into the fire before the spittle dries. Of course, such a patient should never kiss anybody and should not sleep in the same room or eat or drink from the same glass or cup or spoon as anyone else. Never drink out of a public drinking cup. You can never tell what dangerous or disgusting disease the last person who used it may have had.

Children and young people often have enlarged tonsils which should be operated upon because of the tendency to tonsilitis and other diseases of the throat, and to trouble causing deafness. The same is true of adenoids, lumps which form in the upper part of the throat above and behind the palate. Both of these interfere with natural breathing through the nose. Such a child has to keep his mouth open and is a mouth-breather. It gives the child a stupid look and really does make him more or less defective bodily and mentally besides threatening to make him deaf.

TEETH AND THE X-RAY.

When one or more of the second teeth fail to erupt, or to come through the gums, at the proper time, the dentist has to decide whether to try to preserve the first tooth, which he certainly would do if he knew that the second tooth was never coming. Or if the baby tooth has already been lost, he has to decide whether to keep that space open for the second tooth to grow into; but if he knows that there never will be any second tooth he may close up the space and regulate the other teeth to correspond. In this case he will use the X-ray to see whether the germ of the second or permanent tooth is in the jaw or not.

The X-ray is produced by the most powerful electric currents and shines through objects which are of light weight regardless of their color or transparency to ordinary light, while it is more or less obstructed by heavy substances. Looking through the hand the flesh seems very transparent, the bones look much darker and a metallic substance like a bullet is perfectly black.

CHAPTER XXXIV.

Common Sense Treatment of Ordinary Injuries Before the Doctor Comes or When a Doctor Can Not be Obtained.

FIRST AID TO THOSE WHO HAVE BEEN INJURED.

MANY of the accidents and injuries which happen to children and young people are not of a serious nature, nor do they require any special skill in their treatment. Even many of the severest forms of injury such as happen most frequently in cities, with their great variety of dangerous occupations, receive their first attention from the ambulance surgeon, who is the junior member of the hospital staff and sometimes has not even received his doctor's degree. And yet how few complaints are made about ambulance surgeons, at any rate in regard to their care of the injured, the principal reasons probably being that they usually exercise common sense and self control, and do not attempt to do anything more than to meet the immediate necessities of their patients, hurrying them to the hospital as quickly as possible where they will receive the attention of those who are more experienced and more skillful than they are.

These are the qualities then, which are necessary in attending to the first wants of the injured: common sense, self-control, and attention only to immediate requirements. But that which must be remembered first, last and always in any attempt to serve the injured, is the gospel of cleanliness which, if it ever comes before godliness is in connection with the treatment of wounds; for if there is anything which is settled in surgical practice it is that wounds which receive clean treatment almost invariably do better than those which do not receive such treatment.

ARTICLES FOR THE TREATMENT OF INJURIES WHICH SHOULD BE IN EVERY HOUSEHOLD.

Of course nobody can tell when a member of a family is going to be injured, nor can anybody tell what that injury is likely to be. But there are certain articles which should be in every household in anticipation of wounds and injuries, which should always be at hand in case they are needed. If they are never required, so much the better; the expense in purchasing them is not large, most of them will keep indefinitely, and they should be in every family medicine closet or chest. They constitute a form of accident insurance, and when they are needed, they are usually needed very badly, and at once.

INSTRUMENTS.

One pair of strong scissors. Two or three cards of safety pins, of different sizes. One pair of medium-sized dressing forceps. One strong knife. One flexible probe. Two artery forceps. Large and small surgeons' needles, half curved, with large eye. Two or three glass spools of surgeons' silk, of different sizes, in sealed tubes. These instruments will suffice for all ordinary injuries. They should be kept in an air-tight metal box, which should never be opened except when they are required for use. They should be dropped into boiling water before being used, and after being used they should be boiled five or ten minutes, and wiped until they are thoroughly clean. They must not be put away with dirt or blood or anything else upon them. To this list may be added a hot water bag and a two-quart fountain syringe. All these things can be purchased at any reliable instrument shop.

DRESSINGS.

These are the coverings which are placed upon or around wounds or injured portions of the body. Six muslin or cheese-cloth roller bandages, two inches wide and five yards long. Six of the same material, three inches wide. One roll of rubber plaster, three inches wide, which can be split into narrow widths, if necessary. It is a most valuable dressing and instantly adheres to anything to which it is applied. One half pound roll of absorbent cotton. One five-yard package of sterilized gauze.

ANTISEPTICS.

One bottle of tablets of bi-chloride of mercury. One four-ounce bottle of peroxide of hydrogen. One jar of vaseline. One four-ounce bottle of lysol. The dressings and antiseptics can be purchased at any reliable drug store, and should be kept in a box or closet by themselves, where they can be obtained at a moment's notice. Other necessary articles including soap, towels, hot water, and a clean and stiff brush for the hands and nails are available in every household. It is especially important that these various articles be always kept in the same place, for there is no time to search the house for them when an accident has occurred.

SELF-CONTROL THE FIRST REQUISITE IN HELPING THE INJURED.

Any person who can not keep his wits about him in the presence of any kind of an accident is in the way and should give place to others. It matters not how well you may have learned the theory of helping the injured, if you can not apply it when the important moment arrives.

PREPARATION FOR GIVING ASSISTANCE.

Being confident that you have yourself entirely under control, be sure that an abundance of hot and cold water, basins, towels, soap and scrubbing brush, are at hand. Then quietly get the other supplies in readiness. No matter what the injury may be, it is always desirable that you wash and scrub your hands and arms before attempting any kind of assistance. Place a basin of hot water near you, containing one of the tablets of bi-chloride of mercury, and immerse your hands in it at short intervals, not wiping them afterward, but keeping them moist while you continue your work. Cover yourself with a clean white gown, or large apron, or sheet. You can not tell what kind of a mess you may get into, and the gown or sheet will protect your clothing, and also be a protection to the patient.

PREPARATION OF THE PATIENT.

Place the injured person at full length, upon a stout table, in a good light. If the injuries are slight, and are upon the upper half of the body, the patient may sit in a chair, but he will be less likely to faint if placed in the horizontal position, and it will be easier to examine him in this position. Remove as much of the clothing as will enable you to examine the injury carefully, and make the necessary dressings. Generally it is impracticable to examine an injury through the clothing. Suppose, for instance, there were bleeding, with very little outward appearance of it, how could you check it unless you first removed the clothing and saw exactly the portion of the body from which the blood was coming. If the patient tells you he has an injury of the leg you would not expect to remove his upper garments to find it and treat it, but if he is to be placed in bed afterward, it may be well to remove most of his clothing before beginning your work. Having exposed the region of the injury, wash it carefully with the solution of bi-chloride of mercury which is at your side, applying it with a swab of gauze or cotton. Sometimes it is necessary to make the examination without this preliminary cleansing, but do not dispense with it if you can help it. One person should make the examination and treatment, but there should be assistants to carry out his orders; one to hand him instruments or dressings; one to get additional supplies if required; a third to assist directly with the patient, sponging the wound, assisting in bandaging or doing anything else which may be required. Each person must know just what his duty is to be, confusion during an operation, however simple, being demoralizing, and particularly so among amateurs. These steps having been carefully carried out, the patient is examined and the treatment proceeded with.

BITES.

Bites are usually, though not always, poisonous injuries, and the development of the poison within the body is the thing to be considered and prevented, as well as the care and treatment of the wound. Poisons differ according to the cause which produces them, and their effect varies with the resisting power of the person who has been bitten. Bees, mosquitoes, gnats, and other insects introduce a poison into the skin, but the result is seldom serious, unless the number of bites is very large. Such wounds should be frequently bathed with ice water, alcohol, ammonia, boric acid, or some form of soothing lotion. Snake bites are often serious but not so often fatal as is usually supposed. The most serious are those of the rattlesnake, copperhead, and moccasin. The wound should be carefully cleansed as quickly as possible, enlarged and allowed to bleed freely, and then cauterized with pure carbolic acid or a hot iron. The bowels should be opened with two or three compound cathartic pills, and the kidneys and skin kept actively at work in the hope of expelling the poison. Bites from dogs and other animals are not serious unless the animal is diseased. The wound should be cleansed, cauterized with carbolic acid, and examined and dressed daily. If there is any reason to suppose that the animal has hydrophobia, the bitten person should be taken as quickly as possible to an institution where that disease is treated. Frost bites should be bathed with cold water and the frozen parts rubbed vigorously until the circulation is restored. The injury is sometimes so severe that the frozen portions are destroyed. The fingers, toes, nose and other exposed portions of the face are most frequently attacked.

BLACK-EYES.

Such injuries are known as contusions, the discoloration and swelling being caused by bleeding into the tissues under the skin. Similar injuries may occur in any portion of the body, as the result of blows. The discolored skin gradually grows lighter as the blood is absorbed. Little treatment is necessary except rest and the application of cold compresses.

BOILS.

These painful swellings frequently come in groups, one after another, especially upon the back of the neck. Carbolic acid carefully applied at the beginning of the trouble, will often arrest it. Abscesses and carbuncles are similar inflammations but are not the same. A hot-water bag will soothe the pain and hasten the formation of pus. These inflammations will get well much more quickly than otherwise if they are opened with a quick and rather deep cut and allowed to discharge freely. A tablespoonful of castor oil or two compound cathartic pills, or some other purgative, should be given to open the bowels thoroughly.

BROKEN AND DISLOCATED BONES.

These injuries are too serious to be treated by any unskilled person, but it may be hours before a physician can be obtained, especially in the country. A dislocation means that the ligament which surrounds a joint has been torn, and the head of one of the bones which form the joint forced out of its socket, through the opening which has been made. The bone must be restored to its place and kept quiet in a suitable position until the injured tissues have healed. Only one who is familiar with the proper relations of the injured parts to each other can do such an operation. But before the doctor comes the patient's clothing should be removed, cut away if necessary, the patient placed in as comfortable a position as possible in bed, and the injured joint surrounded with cold cloths. If the pain is severe the cloths may be moistened with a soothing liniment, such as chloroform liniment. The sooner the bone can be replaced the better, for the more the muscles contract around it the greater will be the force which will be required to bring it back again to its proper position. Any of the bones of the body may be broken, but those of the upper and lower extremities suffer most frequently from such injuries. The separated ends of a broken bone can often be felt, and they will produce a peculiar grating sound when rubbed against each other. The surrounding muscles will usually contract and pull one end of the broken bone over the other. If these ends are not properly separated and readjusted the limb will become shorter than a healthy limb should be. When the end of the broken bone pierces the tissues and protrudes through the skin the injury is called a compound break or fracture, and when there is no opening of the skin it is a simple fracture. The former is the more dangerous and takes longer to heal. An X-ray picture will show the exact position of the bones and should always be obtained when possible. An unskilled person should not attempt to treat such an injury, but he can place the patient in as comfortable a position as possible, wash and cleanse the wound, arrest hæmorrhage by careful pressure, and bind thin pieces of wood or strong pasteboard on either side of the limb, being careful always that the bandage is not too tight and that it is applied *from below upward.* Cold applications and soothing liniments may be applied as in the case of dislocations. The broken bone must be *set* as soon as possible and it will help the surgeon, and save much valuable time, if all the preliminary steps here mentioned have been taken so that when he arrives the patient will be entirely prepared to receive his attention.

BRUISES AND LACERATIONS OF THE TISSUES.

These may be of any degree of severity, from a simple breaking of the skin to extensive crushing of the tissues. With such injuries it is better to have the patient lying on a table, as it is easier to get at it, and the patient is less likely to see it, and be frightened by its repulsive appearance. Besides he is less likely to faint while lying down and thus cause additional trouble and alarm. Having exposed the injury, gently cleanse it with hot water, removing the torn clothing and dirt and blood which are around the wound. Do not attempt to remove the blood clots from the wound itself, for that is the means which nature has taken to stop the hæmorrhage. If bleeding occurs while the wound is being dressed, find the place from which the blood is coming. It may be arrested by firm pressure with a gauze sponge moistened in bi-chloride of mercury solution, if it should simply be an oozing; but if it comes in intermittent jets it is from an artery, and the end of the artery must be found and grasped with artery forceps. The forceps being tightly closed upon the bleeding vessel, the latter must be tied, *beyond the forceps,* with a piece of strong silk thread. You must not be afraid, for in the presence of such bleeding nobody can be timid or cowardly. The wound having been thus prepared, shreds of hanging tissue must be trimmed away, and the wound covered with a pad of gauze moistened in the bi-chloride solution. A suitable bandage should then be applied and the patient placed in bed. When the doctor arrives he will probably find the work so well done that he will compliment you on your skill and presence of mind. Let the wound alone, and merely give the patient something to relieve his pain.

BUTTONS, BONES, PINS, ETC., WHICH HAVE BEEN SWALLOWED OR PLACED IN ONE OF THE CAVITIES OF THE FACE.

All these substances are known in surgical language as foreign bodies. Small specks or cinders may also become embedded in the mucous membrane of the eye and cause great pain. If they can not be wiped away by the gentle application of a clean handkerchief it is not wise to make further attempts at their removal, as it will only result in fixing them the more firmly, and increasing the pain and other disturbance. Cold cloths should be placed over the eye and frequently changed. As soon as possible you should get the assistance of a competent oculist, who will quickly remove the offending material. Children, in the spirit of mischief, will often put beans or beads, or even bugs in the nose or in the ear, causing great pain and sometimes very serious consequences. As soon as possible after this has occurred the child should be firmly held where the light will shine into the cavity, whether the nose or the ear. Then if the offending substance can be seen it should be gently, but firmly, grasped with the dressing forceps and withdrawn. If it is too firmly fixed to be withdrawn it should be thoroughly crushed and the fragments washed out with a gentle current of warm water from the fountain syringe. If any of these substances has been swallowed by a child, or if a small bone, or coin, or buckle has been swallowed and has passed into the stomach, there is usually very little cause for worry; in due time it will pass through the cavity of the bowels and be expelled. As a measure of safety, however, several figs may be given to the child, or oat meal, or corn meal porridge, which will cover the offending body and prevent it from injuring the bowels while it is passing through them.

BURNS AND SCALDS.

These painful injuries may be slight, or very severe and dangerous. The patient should be made to lie down and the burned surface carefully exposed. Do not touch or handle the burned portion, as the slightest touch will increase the pain. Then spread a thick layer of vaseline upon a sheet of absorbent cotton and bind it smoothly, but not too firmly, over the wound. Instead of vaseline, a mixture of equal parts of olive oil and lime water may be spread over the cotton. The dressing must also be kept moist with a solution of baking soda, a tablespoonful being dissolved in a pint of cold water. It will usually be desirable to leave the dressing in place a week before removing it, and by that time the wound will have healed. If the bruise is a severe one a physician should be summoned, for serious complications are possible.

CUTS.

The smaller injuries of this character are of little importance. All that is necessary is to cleanse them carefully, bring the edges together and apply a strip of rubber plaster, keeping it in position four or five days. If the cut is a large one, and the bleeding is profuse, check the latter by pressure in the way which has already been described. If the wound gapes, a few stitches should be taken, each stitch being tied and the ends of the silk cut short. The wound should then be carefully cleansed, covered with moist gauze, and a strip of plaster bound around it.

DROWNING.

When a person has apparently been drowned he should be stretched upon the ground and his clothes loosened. If a spark of life remains it will often be possible to revive him. Place your ear against his chest and see if you can detect even the faintest action of the heart. If that organ is still working, the next thing will be to bring the lungs into action, for the condition is that of suffocation. Now raise the person by the feet so that the water may run out from the lungs and stomach, or place him upon a barrel, face downward, and roll the barrel back and forth a few times. Then lay him on his back, seat yourself at his head, grasp both his hands and raise them until they are stretched above his head. This permits the air to enter his lungs, and the lungs to expand. Then lower his arms, bringing his hands together upon his chest and gradually compress the chest. This forces the air out of the lungs. Repeat these motions until natural breathing is resumed, or until it is evident that life is extinct. When the breathing has become natural and regular, rub his hands and arms vigorously until the skin becomes red and warm. Then place him in bed, and put hot-water bags or bottles wrapped in towels around him. They must not be so hot that he will be burned, and remember that many accidents have occurred from failure to observe this precaution. When consciousness has returned, give him a hot stimulating drink. Recovery from such accidents is usually prompt, if at all.

FALLS.

These are very common accidents among children. First arrest the bleeding, if there is any, then cleanse the wounds or bruises, examining carefully for broken or dislocated bones. Place the patient in bed, and if he is unconscious raise the foot of the bed about eighteen inches. Stimulate with heat at the extremities and rub the body briskly. The unconsciousness may be due to a fracture of the skull, hence a physician should see the patient as soon as possible.

NOSEBLEED.

This is seldom harmful, and very often it is beneficial if not too profuse. If it should continue too long, moisten a string of absorbent cotton or a piece of lampwicking with a hot solution of alum, two teaspoonfuls to a pint of hot water, and carefully plug the nostril from which the bleeding comes, pressing the cotton into the cavity with dressing forceps. If this should be insufficient, remove the packing and apply a fresh one. If this should fail to stop the bleeding you will certainly need the help of a physician.

SPRAINS.

These are very common and very painful injuries, and are caused by stretching or twisting a joint with its tendons and ligaments. The ankle is most frequently the seat of this accident. The injury should be carefully examined to see whether bones are broken or dislocated. The treatment is simple and consists in perfect rest of the part, with elevation of the limb, and the application of cold compresses until the swelling has subsided. Then the injured portion should be carefully bandaged from below upward. Frequently a plaster-of-paris bandage is used.

SUNSTROKE.

Quick action is always necessary. Remove the clothing, place the patient in a cold bath, or wrap him in a sheet moistened with icewater, and apply ice to the head. When consciousness returns, give him a draught of hot tea or coffee, or a teaspoonful of aromatic spirits of ammonia in a glass of water.

POISONS.

The treatment of poisoning in general, is too large a subject for a work like this. The general principle may be remembered that poisons which depress, like illuminating gas and various narcotics, must be treated by stimulants, while those which irritate or stimulate, like alcohol, by soothing or sedative substances; acid poisons should be treated by alkalies; for example, carbolic acid poisoning by the whitewash or lime which may be scraped from the wall of your house. The stomach of one who has been poisoned must be emptied as soon as possible. This may be quickly accomplished by giving a glass of lukewarm water in which a teaspoonful of mustard has been dissolved. Many plants are poisonous even to the touch. The poison-ivy is a plant with which many children have had unpleasant acquaintance and produces a very troublesome rash on the hands, feet, neck, and body. As good an application as any for this eruption is a solution of baking soda with which the skin should be kept constantly moist.

BANDAGING.

Bandaging is an important means of treatment, and is not difficult to learn in its simpler forms. The chief point to remember is that it may interfere with the circulation of the blood, and that, therefore, it must not be too tight. On the other hand it must be firm enough to produce the desired pressure, and should not slip out of position. The careful rolling of one layer of bandage upon another is simple enough. If the successive folds do not lie closely and smoothly together, reverse the bandage, that is twist it so that the lower side will face upward, and do this as often as may be necessary for a smooth and sufficiently firm dressing.

CHAPTER XXXV.

Some of the Reasons Why Young People Wear Out.

IMPORTANT FACTS EVERY BOY AND GIRL SHOULD KNOW.

WHEN a little child is born, its future is unknown, but it is always a subject of fond hopes to its parents; no outside force ought to interfere with its reaching whatever goal it may deserve and seek, and this is what our forefathers meant by declaring that "all men are born free and equal."

As soon as the child grows older, however, differences in body and mind, and differences in social surroundings, between one child and another make themselves felt, with cruel severity, and while one life goes on to health, wealth, and happiness, another is overwhelmed by sickness, poverty, and misfortune.

It is not enough to say that such differences always have been, and must always continue. Many or most of them are due to ignorance or faults of the parents, or grandparents, of the child; many are due to the foolishness, or worse, of the child who will not obey its parents or teachers, nor take advantage of what opportunities it may have.

Still we can see from age to age that the world is growing better; poverty is less, life is more secure, better care is taken of children, and better education is offered them. Little children have less sickness than formerly, and fewer of them die. Science is conquering diseases, and removing the causes of them. Every boy and girl in growing up should try to help along the good work, remembering that every generation is responsible, not only for itself, but for the health and happiness of generations yet to come.

Every human being, like a tree or an animal, will come to maturity and to old age, unless something interferes to prevent it. No one knows what the mysterious force of life is, but it is strongest in the youngest, and runs on until it runs down. A man or woman should live to seventy or eighty years, but how many wear out and die too soon! How many linger for years as human wrecks before they die!

Now the causes of such untimely sickness and death are most often laid in childhood, or even inherited from ancestors, for there is nothing truer than that the sins of the fathers are visited upon the children unto the third and fourth generation.

The disease or weakness that is inherited may not show itself clearly, but only as a liability to disease, a feebleness, and a want of resistance, so that the unhappy child is unable to stand the exertion of work or play; it grows puny and delicate, and a victim of one disease after another, until finally it wears out.

Sad as it is to see young lives wasted and ruined from ignorance, from folly or vice of the child or of its parents, it is sadder yet to see children ruined and destroyed wholesale by the ignorant carelessness of the community, or by the heartless greed of employers, or of parents or guardians.

With all the boasted advantages of civilization there are grave evils which go with it; particularly the attraction of great masses of people from the country, and their collection in huge, crowded cities, where strength and vitality wither away under the influence of poverty, strong drink, insufficient food, and want of fresh air and sunlight.

Then follow diseases, notably tuberculosis, which attacks the pale children of the country people, who have left their farms and changed their whole manner of living. Herded as they are into tenements and workshops, this infectious disease spreads from one victim to another, in its various forms of scrofula and consumption. Little children are infected in infancy through milk, or by swallowing or breathing in dust infected by the coughing and spitting of older persons. Thousands die in childhood, other thousands grow up weakly and stunted, only to wear out in a few years more, just on the threshold of maturity.

Then come the grim conditions of poverty; insufficiency of food, of clothes, of light and of air, and work, always work.

It may be said that country children also have to work, but their condition is very different. Chopping and bringing in wood, caring for cattle, working in the fields, weeding, hoeing, haying, picking berries, always in the fresh air and sunlight—such work does not wear out the child physically, even when somewhat excessive. In the country cases of overwork, neglect or abuse of children are often noticed by neighbors and prevented by public opinion, or punished by municipal law.

EVERYONE IS INTERESTED IN CHILD-WELFARE.

In cities, however, especially in industrial centers, in mills, factories, and mines, where evil laws tolerate or sanction child labor, where the operatives are ignorant and very poor, enfeebled, sodden with drink, where families are large and wages low, where often the breadwinner is dead, or sick, or lazy, or drunken, a shocking oppression and cruel bondage of children prevails.

The young life meant for play, for school, for development in fresh air and sunshine, is crushed and ground down by long hours in hot, dusty, ill-ventilated rooms, until nature gives way and the poor child, wrecked in body and stunted in mind, is thrown aside to wither and die.

It may be said that this is inevitable; that poverty and hunger know no law; that where the labor of children is necessary for the support of the family they must work, and take their chances of wearing out; that the strongest survive, and that this is only an instance of natural law, and of the grim struggle for existence.

This is a false and wicked view of the matter. In the natural struggle for existence of the savage, the child does not suffer except in times of unusual calamity, when it suffers with the rest.

The industrial destruction of children is a vice of so-called civilization; it is a consequence of greed, ignorance, and drunkenness. It must be fought with and conquered. Over the helpless child the State must extend its protection, and it is part of the recent moral awakening of America and other countries that public attention is being called to the evils of child-slavery, and that a stronger and stronger demand is ever going up for laws for the protection of children.

It is the duty of all who have the welfare of children, and the whole community, at heart unceasingly to demand laws, and better laws, for the protection of children. In enlightened communities there are societies which not only work to obtain such laws, but work incessantly to see that the laws are observed, and in all sorts of ways care for the interests of children. There should be more such societies and all should work to establish them.

In the United States some of the States are far in advance of others in regard to laws for the protection of children. As the very reason why children are employed and overworked in factories is that the cost of finished goods is lessened, it is evident that the manufacturers in States which do not protect children have an unfair advantage over makers of similar goods in States where child labor is not permitted.

For this reason there is at present an agitation in favor of invoking Federal law to forbid interstate commerce in goods produced by improper and injurious labor of children. If such a Federal law can be passed, and is constitutional, it will be welcomed by all friends of children, that is, by all right-minded people.

Even without Federal assistance, however, a wise regard for the health and intelligence of its citizens should lead every State to enact laws for the protection of its children.

No State can profit for a long period by allowing either its women, the future mothers of its citizens, or its children, to be overworked, and in spite of the grumbling and opposition of greedy employers, there is a continual improvement in the laws for the protection of women and children.

Massachusetts is a State that has long been distinguished for the careful legal protection of children, and those States which are allowing their manufacturers to employ children improperly, or which permit heartless parents and guardians to drive their children to work when they ought to be at school or at play, might do well to copy the statutes of Massachusetts, and of other enlightened States.

Likewise the Children's Aid Society, which watches over children to see that the laws are enforced, and in every way helps to guard and protect the little ones is a Massachusettetts institution, and is worthy of imitation everywhere.

Under the laws of Massachusetts, schools must be and are maintained at the public expense, by cities or towns, sufficient to accommodate all children of school age. Special schools are provided by the State, for the deaf and dumb, for the feeble-minded and for the blind; reform schools are supported by the State for vicious children, who are unfit to mingle with good children.

All children up to fourteen years of age are required to attend school, and truant officers see to it that they do attend. If children do not come to the public school the parents must show that they are receiving proper education in approved private schools or from private tutors. If physically unable to attend school, it is required that the illness or incapacity be proved to the satisfaction of the school authorities.

No child under fourteen years of age, in any case, or under sixteen years, unless it can read and write the English language, is permitted to work in any factory, workshop, or mercantile establishment. No child under the age of fourteen years shall be employed at work performed for wages, or other compensation, during school hours or before 6 A. M. or after 7 P. M. There are strict provisions as to certificates of age and schooling to be obtained by children at fourteen years of age, and no employer under heavy penalty may employ any child under sixteen years unless he has such a certificate. Truant officers may arrest any child found working illegally and report the employer for punishment.

When at fourteen a child receives his age and schooling certificate, still no one may employ him without a certificate from the school physician that the child is physically able to perform the work which he intends to undertake. There are all sorts of provisions to protect children and keep them from dangerous, unwholesome, or morally contaminating employments.

All cities and towns are required to employ physicians to examine the school-children. The physician must report on the condition of the sight and hearing of such as are found defective in these senses, after simple tests applied by the teachers; they must examine all children at proper intervals and especially watch over the symptoms of contagious diseases. The teachers are instructed by circulars of the Board of Education as to the first symptoms of ill health in pupils.

No child may be admitted to a public school unless it has been vaccinated, and in this way smallpox is substantially kept out of the community. Vaccination is now generally considered an indispensable public necessity, and yet there are always some people who oppose its performance. To seize the children and vaccinate them by force, or to prosecute the parents and send them to jail for refusing to permit vaccination of their children, seem too harsh measures for a free country; but the continual necessity of paying for private instruction of a child which has not been vaccinated, overcomes in time the opposition of all except a few skeptics, and thus vaccination quietly becomes universal.

In the cities, school-nurses are employed who not only watch over the health of the children in the schools, reporting to the school physicians all cases requiring medical attention, but they go to the homes of the children, talk with the mothers, instruct and warn them, show them the necessity of proper food, clothing and cleanliness in their children and help in many ways to bring up the family properly.

Many or most of the States have labor laws protecting children; but in not a few States the laws are very imperfect. Good men and women, however, are at work everywhere. There is a General Association for Labor Legislation with headquarters in Switzerland and with national branches. The American branch is at work everywhere in the country, drawing public attention to the necessity of proper laws for the protection of children. The Bulletin of the United States Bureau of Labor for 1911 shows that in 1908 and 1909 fifty-four laws were enacted by the legislatures of thirty-two States concerning the labor of women and children. These laws are largely based on the idea of compulsory attendance at school, so that they necessarily limit and regulate the employment of children. There are increased safeguards as to determining the true age of children, stricter regulations as to the hours of labor, the prohibition of night work, and of dangerous employments. On the whole it is apparent that the world is awakening to the necessity of protection of the children, and is using the school laws as a proper and ready means for saving them from overwork and other abuses.

CHILDREN MAY RISE ABOVE CONDITIONS.

Sadder yet than the overwork of children in mines and factories, is the terrible waste of young life, health, and morals which goes on by want of training and care in the home, and even in the school. No child who has grown up in a good and happy home, carefully reared and guarded by fond and wise and good parents, can realize what other children have to go through, growing up under opposite conditions. And yet such is the force of character on the one hand, and the evil influence of a bad nature or bad company on the other, that we frequently see children who have grown up under the most terrible conditions, yet developing into good, strong and healthy men and women, while other children who have had every advantage form evil associations and habits, sink lower and lower until they die, or are imprisoned, or are lost in the under world of the vicious and ignoble, the drunken and destitute.

It is surely a hard thing for a child to be born into the world with evil tendencies, or faults, or weakness of body or mind or moral nature, inherited from ancestors—but there are two conditions which should ever be before the mind of every young person. First, that even inherited faults can be overcome by determination and effort; and second, that everyone has a duty not only to himself or herself, but also to the children and to the grandchildren who may descend from him or her. Right conduct consists in endeavor to do right, and a steadfast purpose will neutralize many a vicious influence and environment.

Nevertheless it is a sad fact that many a young life is wrecked by the evil influence of a bad home. Drunkenness, dishonesty, immorality, gambling, foul language, want of cleanliness, want of discipline, allowing children to run about the streets, especially at night, in bad company—all these things tend to set a child in the wrong track and expose it to contamination with various vices that seize on the young person when childhood passes into youth and that woefully wreck the young life.

Even at school the child is not free from dangers of many kinds. All are there gathered together, the good, bad and the indifferent, and there is constant danger that the good learn vices from the bad. Even more this is the case when work begins in the shop or factory. Happy is the child who has a wise father, a good mother, or a devoted sister to guide and guard it through these years.

Unfortunately many people who mean to bring up their children properly have very little wisdom, and are ignorant of the dangers that beset childhood; in other cases neglect and even abuse are so evident that protection for the child is necessary, and is afforded more or less by school laws, children's aid societies, children's courts, and by the gradual formation of an enlightened public opinion.

We hardly need to mention here some of the obvious evils to which children are exposed when they grow up in scenes of drunkenness and immorality; when they are allowed to run wild in the streets at all hours, in bad company; when they learn early to drink, and to smoke cigarettes, and have their young minds poisoned by blasphemous language and dirty stories, so that as they get a little older they fall easily into ways of vice that surely undermine their health.

There are certain definite causes of the wearing out of the young body, however, that are not so well understood, and which require vigilance on the part of parents and school authorities, in order that they may not fasten on their young victims.

Such are tuberculosis and other contagious diseases, faulty teeth, imperfect eyesight, crooked spines, obstructions to proper breathing, insufficient fresh air and exercise, improper food, bad and vicious habits in regard to the development of the sexual nature.

As it seems impossible to get sufficient attention paid to many of these subjects on the part of parents, owing to ignorance or indifference, it has been found necessary to enlarge the scope of the school system. By the appointment of physicians and nurses to examine the children in the schools, and to visit them in their homes, and to gain the coöperation of parents and guardians, a vast amount of good is accomplished in cities which have introduced such a system of inspection.

Teachers are also able to do a great deal to aid in this good work and by means of instruction through circulars of the Boards of Health they are able to call cases to the attention of the school physicians requiring examination and care.

In regard to tuberculosis, ‘‘the white plague,’’ modern science has shown not only how it is acquired, but how it may be arrested in its early stages, and thus the greatest cause of the wearing out of children is now persistently fought, and is gradually and steadily diminishing.

Under the head of tuberculosis is to be understood not only ordinary consumption of the lungs, but all the various forms of white swellings or tuberculous disease of the joints, and the various forms of what people call scrofula.

At last the public conscience, as well as public alarm, has been awakened and a persistent attempt is being made to improve the conditions under which the masses of the people live, to give better dwellings, to remove consumptives from tenements and from facto-

An Outdoor Kindergarten Class at an American Public School.

ries, and to give them treatment in suitable hospitals, and especially to teach them to live properly at home without infecting other people, particularly the children of their families.

WHAT BOARDS OF EDUCATION ARE DOING FOR THE CHILDREN.

In the most enlightened cities not only are the children who are tuberculous discovered by school physicians, but special open-air schools are established where, even in winter, these unfortunate little ones, have open-air treatment all day, with special food, while they still continue their studies. Such a new development of care of tuberculous children is the open-air school at Franklin Field, Boston.

After all, success in the struggle against tuberculosis must depend, in this country at least, on the education of the whole people, so that the question will be thoroughly understood, and suitable laws passed and enforced. The public-school teacher is able not only to notice and call to the attention of the school physician any symptoms or appearances in any pupil which indicate failing health, but can and should instruct the scholars in regard to the nature of this plague, how it is acquired and how it should be avoided and overcome.

To this end the Massachusetts Board of Education has issued a booklet of "Suggestions to Teachers on Tuberculosis and its Prevention" and another booklet of "Suggestions to Teachers and School Physicians on Medical Inspection."

One of the great causes of failure of health in children is poor nutrition and poor digestion, caused by bad teeth. As a nation, by a curious blindness and folly, we use only flour from which the part of the wheat most essential for nourishing the teeth has been removed to make the flour whiter. The same may be said of rice. Moreover the consumption of candy and other sweets in the United States is far greater than in any other part of the world. Thus the children's teeth, with lower resistance, are constantly surrounded with fluid containing sugar, and such fluid breeds germs which attack the teeth. When the teeth are decayed the mouth is contaminated with fluids which are swallowed and injure digestion and also slowly poison the child. It is an expensive matter to care for and save such teeth, so they are pulled out and the child has to go through life without proper means of chewing its food.

Careless parents do not insist upon the proper cleaning of the teeth of their children, and the children are lazy and thoughtless in regard to their care, and thus, from all these causes, we have, as a nation, the worst teeth in the world. Much can be done by teachers in observing, warning, and instructing children in regard to the condition of their teeth, and the importance of the subject, and the method of taking proper care of them.

In Boston a million dollars has just been given to establish a dental clinic for the care of the teeth of the school children and of all young people up to sixteen years; other suitable institutions will be established in other places, as knowledge of the need for them becomes better known, but after all it is a diffusion of knowledge among all the people through the schools which will finally overcome this great cause of the wearing out of young people.

Another cause of wearing out of some children is imperfect development, caused by obstruction to breathing, due to want of space in the nose and upper part of the throat.

Many children have swollen tonsils, or a soft growth like a tonsil behind the nose, at the top of the throat, so that breathing is obstructed. The child learns to breathe with the mouth open, and this makes matters worse, for it is not a natural way to breathe, and requires constant effort. As a consequence the passage in the nose gets narrow from want of use, the shape of the jaw is altered, the teeth are crowded on each other and decay, the chest is poorly developed and flattened, the lungs are smaller and poorly expanded. The child has no ''wind,'' can not run well nor play as others do, and is particularly apt to have disease of the ears or of the lungs.

Therefore all children who sleep with the mouth open, or who keep the mouth open most of the time when awake, should be carefully examined, and in substantially all cases there will be found to be some impediment to proper breathing which can be remedied by surgical measures.

Defects in eyesight or in hearing, crooked spines, and various other troubles which sadly handicap the child in the struggle for existence, are likewise detected by proper examination in the schools. Contagious diseases are immediately discovered, epidemics checked and controlled; early medical treatment of many serious conditions is obtained at a time when the diseases are curable and so grave consequences are prevented. Good school laws with ''proper medical inspection'' are thus at the very roots of national health, as well as of national education.

Another great cause of the wearing out of children can not be reached effectively by laws and can not even be discussed at length here, but requires constant, quiet, wise direction by parents, teachers, and the church. We refer to the proper guidance of the child as it grows up and begins to mature. The awakening of the sexual nature is natural and inevitable. Proper information and instruction as to sexual matters should be given by fathers and mothers, or by others in authority, so that the growing child shall not be led to seek such knowledge from playmates or others.

At the age when the mental and moral nature of the growing child is entirely undeveloped, its body has grown to a stage where grave damage may arise from distortion of its moral nature, and injury or disease of its body, through vicious ideas and habits learned from others.

The sensible child will believe that its parents are right in trying to keep it out of bad company and away from evil communications. It will avoid companions with bad talk and bad habits, and will frankly ask father or mother as to subjects on which it needs and should have information and guidance.

CHAPTER XXXVI.

Some Important Things Mothers Should Know.

CLOTHING FOR THE BABY.

THE new-born baby must be warmly clothed, remembering that it takes time for it to get accustomed to the climate of the world into which it has come. The clothing should be very loose, for it takes time also to get accustomed to wearing clothing, and if it is tight at any point the blood will not flow at that point as freely as it should.

Young people who have played in a brook, and have put stones or dirt in it to make a dam, know that the water collects in a pool behind the dam and the ordinary flow of water is stopped or hindered. Practically the same thing takes place when clothing is bound too tightly around a child at any portion of its body.

THE BABY NEEDS THE RIGHT KIND OF AIR AND WARMTH.

The temperature of the room in which the new-born baby is kept must be warmer than that of the rooms where the other members of the family live, but it must not be overheated, and it is extremely important that there should be a constant supply of fresh air. In other words, the air must be kept in motion, and its impurities should be removed, the same as they should be removed from any room where people are constantly taking in air and giving it out again with all the impurities and poisonous gases which we expel from our bodies through the lungs.

If the air in the baby's room is too cold, it will not be long before bad results will appear. A healthy baby breathes through its nose; air that is too cold, colder than the baby can breathe with comfort, quickly irritates certain nerves and causes sneezing. This is followed by swelling of the mucous membrane of the nose, and the baby can no longer breathe in the natural way. It attempts to do it and fails, then it begins to cry, and we say it has the *snuffles,* which is another name for a cold in the head.

In a new-born baby this is a much more serious matter than in a grown person, and it may even result in pneumonia, a disease which is usually fatal in a being as tender and sensitive as this. In any case, the baby loses its strength from constant crying and loss of sleep, and will require unremitting care and attention to give it relief and prevent serious consequences.

THE BABY IS A LITTLE SLEEPER.

No one can have failed to notice the importance of sleep to the new-born baby. If it is healthy and is properly received when it comes into the world, almost the first thing which it proceeds to do is to fall asleep, and for days and weeks it is sleeping the greater part of the time, night and day.

THE FOOD FOR THE BABY.

It does not need much food at first, it does not require much exercise, but it does require a great deal of sleep. If it does not get it the only way it has of expressing its disapproval and unhappiness is by crying, and when a child cries a great deal you may be sure there is something wrong which you must endeavor to find out, for the child is unable to tell you anything about it.

Many people wonder why we do not give food to a child the minute it comes into the world. To feed it during the first few hours of life would in most cases be harmful; it does not want food, it is not ready for it. Just as it has taken time to accustom the lungs to the use of air, and the eyes to the light, so is time also

THE FAMILY.

required to prepare the stomach and intestines for receiving and digesting food.

This is probably the reason why the mother is usually unprepared to supply the baby with the natural food from her body as soon as the baby comes, and she does not often have such a supply for forty-eight hours or more. If that supply should be delayed much longer, or if the baby should evidently be getting impatient for its food, the wise nurse and doctor can usually prepare something which will satisfy the baby until the mother is ready for him.

At all events, they can give him occasional drinks of warm water, which every baby, young and old, ought to have. All mothers should endeavor, if possible, to carry out the plan of nature and nurse their offspring. There are exceptional cases in which this may not be done; a diseased mother, a very feeble mother, is unfit to nurse a child, but unhappy is the woman who loses this joy and duty connected with maternity, and pitiable the woman who rejects this duty merely to suit her convenience or her inclination.

The quantity of food required by a new-born baby is small at first. The baby's stomach, though complete, as a digestive apparatus, is incomplete as to its shape and position in the body. It hangs nearly vertically in the body and will hold only a few ounces, its size and shape being similar to the intestine with which it is continuous.

Any fluid food which the baby may take runs at once into the stomach, is acted upon by the digestive juices at once and passes quickly into the intestine. As the stomach fills up quickly, it is not unusual to see the overflow running out of the baby's mouth, for like many older people a baby frequently doesn't know when he has had enough.

As digestion goes on almost continuously in the baby's stomach, and as the stomach holds so little, it follows that feeding should be at frequent intervals, as often as once in two hours during the day, while at night the intervals may be gradually lengthened in the interest of the child as well as the mother, for it must gradually learn that human beings feed principally in the day-time.

The natural supply of food, as we have already stated, is in the majority of cases by far the best for the baby, but there are instances, be the mother never so well so far as any one can judge, in which it does not digest properly and does not nourish the child. The child cries the most of the time, it does not gain in weight, the movements from its bowels are unnatural, and the indications seem clear that if its life is to be saved, and it is to get strong and healthy, it must have a different kind of food.

THE PROBLEM OF NOURISHMENT.

You can not feed it on corned beef and cabbage, nor on roast beef and potatoes, nor on any of the articles of food which agree perfectly well with grown people. In the first place, it has no teeth, and such food has to be thoroughly chewed before it can be digested; in the second place, the digestive juices which are made in its stomach and intestines are not intended for that kind of work.

The only proper food for young infants is milk, and if the supply from the mother gives out or does not give suitable nourishment, the next best thing is to try and find a young woman with a young infant who has more milk than her infant requires, and let the infant who is in trouble borrow from her supply. Such a woman is called a *wet nurse,* and very often the difficulty may be solved in this way, for the baby never asks any question of his foster-mother and if her milk only agrees with him that seems to be all he desires.

But sometimes the milk from the wet nurse is as unsatisfactory as that from the child's own mother, or perhaps there isn't enough to sustain two babies,

A LITTLE MOTHER.—An illustration of how an older child has to give up its playtime to the care of a sick infant.

or perhaps the supply gives out altogether. Then the trouble begins in earnest, for we evidently have got a baby with a bad digestive apparatus, and one experiment after another must be tried until we can find what the baby likes and what will agree with him, and put him on the road to health and happiness.

Various substitutes for human milk are to be had if we can stand the trouble and expense. Asses' milk resembles human milk and if that can be had it may relieve the situation. But asses with a proper supply of milk are not to be had in every community, and it may be impossible to make such a trial. Goats' milk is also somewhat like human milk, though asses' milk resembles it more closely. Goats are plentiful almost everywhere, and many infants have been successfully reared on such food. But it is by no means uniformly successful, and with some babies it will quickly cause vomiting and diarrhœa.

The form of milk which is more often used than any other when the mother's milk fails, and is always obtainable, is cows' milk. In its ordinary condition it is far less digestible than human milk, chiefly because of the cheese which it contains, which most babies' stomachs can not digest. We are indebted to the investigations of modern physicians and chemists, however, for finding a way of treating or doctoring it so that in the majority of cases it can be made to answer even very difficult requirements.

PASTEURIZED MILK.

Everybody has heard of the practise of treating milk by the process which is known as pasteurization, that is heating it to 140 degrees F., or higher and holding it at that temperature five minutes or longer. Many babies have been brought up on milk which is thus prepared, for it kills the germs which the milk contains which cause fermentation. But it also produces other changes in the milk which many physicians consider harmful, so it is not best to expect too favorable results from such milk.

Many examinations or analyses of human milk have been made and the different elements of which it is composed and their relative proportions stated mathematically. The most successful treatment of cows' milk is that which conforms in the main to these examinations, the proper substance being added to it or taken from it to make it resemble human milk as nearly as possible.

This is the perfection of the art of treating milk for the use of sick babies, and it is now generally practised by skillful and scientific physicians. The three things which are most important to consider, therefore, in the care of young infants are air, food, and sleep.

EXERCISE FOR THE BABY.

Like all other human beings, in fact like all animals, a baby must have exercise. If it lies perfectly quiet all the time when awake it is probably a baby that is not healthy. A healthy baby, after it is a few days old, is always in motion when not asleep, hands, feet, and body are constantly moving, this being its method of exercise.

The custom which prevails in some countries of binding and strapping a baby's clothing around him prevents this healthful exercise and is as barbarous and unreasonable as the Chinese custom of binding a female baby's feet to prevent their growth.

THE GROWING CHILD.

One of the first signs of awakening intelligence in a baby is in the expression of the eyes. It soon begins to notice objects; a light, a moving object, the face of its mother, and follows them with its eyes. A little later it begins to smile and recognize faces, and gives great happiness to the mother and the rest of the family as each new development appears. It is now no longer an unresponsive being "with no language but a cry," but one who is gradually taking on the characteristics of other human beings.

After a few months the faculty of speech awakens, the noises or sounds which he makes being evidence that his brain is undergoing development, and with the utterance of his first word a new era comes into his life. The next noteworthy point in his development is the appearance of the first teeth. This is an anxious period both for the child and his mother. He has now been here about six months, his gums are hot and swollen, he is cross and fretful, and he may have fever. Teething is not a pleasant process for a child, and a similar amount of discomfort in a grown person would be quite likely to make him cross and fretful also.

At length the pearly white object or objects show through the gums and everybody rejoices over the event. The teeth that follow do not cause half the interest aroused by the first ones. Now the baby's food must be changed, for teeth were made for use, and gradually food is given which requires chewing.

Changes now follow in quick succession, the baby is out of the cradle as the fledged bird is out of the nest. He creeps and crawls along the floor. Soon he stands upright, supporting himself by a chair or a table, and before long he takes a step alone and unsupported.

Subsequent changes are less interesting; gradually the mother's supply of milk fails (if she has been fortunate enough to nurse her baby), the teeth assert their importance, and the diet becomes more extensive and varied. Now the mother weans him and the period of babyhood or infancy is ended. Childhood has now been reached, and absolute dependence outgrown. The growing child is now, in a measure, able to help himself.

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